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The Canadian Entomologist

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The Canadian Entomologist

Vol. XC Ottawa, Canada, May 1958 No. 5

Some Species of *Polygrammodes* Guenée (Lepidoptera: Pyralidae)[1]

By Eugene Munroe[2]

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The notes and descriptions that follow arise from material submitted for identification from various sources over the past few years. Doubtless much still remains to be discovered in this genus, and a general revision would be premature at this time. The number of striking new species is surprising: every new collection seems to yield one or two more. Despite the great superficial variation in the genus, the genitalia are very uniform. The main structural variation externally is in the mouth-parts, the labial palpi varying considerably in length and the tongue tending towards obsolescence in many species. There seems to be considerable variation in development of the tongue even in single species, and I doubt if this can form the basis of subdivision of the genus. Most or all of the old-world species and some new-world ones have been wrongly referred to this genus; however, I shall leave the disposition of these extraneous elements to a future paper.

Polygrammodes eaclealis, new species

Figs. 1, 2, 18, 29

Head yellow above, purple at sides; antenna yellow; eye blackish; tongue rudimentary, yellow-scaled, perhaps lacking in some individuals; maxillary palpus yellow at base, black at tip; labial palpus rather strongly porrect, black, with under surface white at base; thorax saffron-yellow, stained with purple on tegula; abdomen above saffron-yellow, with purple mid-dorsal triangles and dorsolateral oblique ovals on most segments, these markings coalescing in some individuals; body beneath white, the white under side sharply demarcated from the yellow upper side; legs white, except for the purple fore femur and tibia. Wings above saffron-yellow, marked with purple. Fore wing with the following markings: a small basal spot; a broad, slightly diffuse, curved, subbasal band, forming an arc from costa to inner margin, tending to be broken into spots by the principal veins, this tendency accentuated in rubbed specimens; a broken antemedial band, composed of an oblique bar from costa, slightly bent on R_5, and terminating at Cu, a slightly diffuse subquadrate patch below Cu, under inner cell-spot, tending to be divided by the fold of 1st A and ending ahead of 2nd A; a smaller patch between 2nd A and inner margin; cell with a round spot beyond middle, a somewhat larger one on discocellular; postmedial band consisting of separate spots in each cell, two minute ones obliquely behind costa, then three of moderate size forming a more or less perpendicular line in cells R_4, R_5 and M_1, then three of similar size forming an oblique series in cells M_2, M_3 and Cu_1, the anteriormost of these set distad of the preceding series of three, but the posteriormost in a line with the preceding series, the spot in Cu_2 large and strongly inset, being slightly basad of discocellulars, incompletely divided from the similar spot in 1st A, another large spot in cell 2nd A, set a little basad of the preceding one, the spots between Cu_2 and posterior margin tending to fuse with the corresponding ones of the antemedial band; basad of

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postmedial band two spots, one in the basal angle of cell M_3, the other in cell Cu_1, a little basad of the first; beyond postmedial band two subterminal rows of faint dots, the inner parallel to the postmedial band, but much less distinct, the outer even fainter, and roughly parallel to outer margin; fringe purplish. Hind wing becoming pale and semitransparent towards costa; a prominent, somewhat lunate, discocellular spot; dots in base of cell M_3 and in cell Cu_1, as on fore wing, but less distinct; postmedial band composed of spots, but less distinct than on fore wing, beginning in cell M_1, the three spots in cells M_2 to Cu_1 offset outward, those behind Cu_2 forming a diffuse shade; the two submarginal rows of spots very faint, often incomplete, best developed in the middle; fringe purple. Under side paler than upper side, costa and fringes purple, most markings of upper side showing through very faintly, only the two cell-spots of the fore wing and the one of the hind wing at all conspicuous, and these much less so than on the fore wing. Expanse: male, 42 to 52 mm., female, 54 mm.

Somewhat like *P. sanguiguttalis* Hampson in general aspect, but with hind wings concolorous with fore wings and with conspicuous purple spots.

Male genitalia with valve rather broad, outer margin oblique, almost straight, with only a slight lobe just behind costa; uncus tapering, weakly bilobed; penis with cornutus a little more than half its length.

Female with ostium surrounded by a sclerotized collar, trilobed posteriorly, bilobed anteriorly; ductus long and slender, bursa small, pyriform, both unsclerotized.

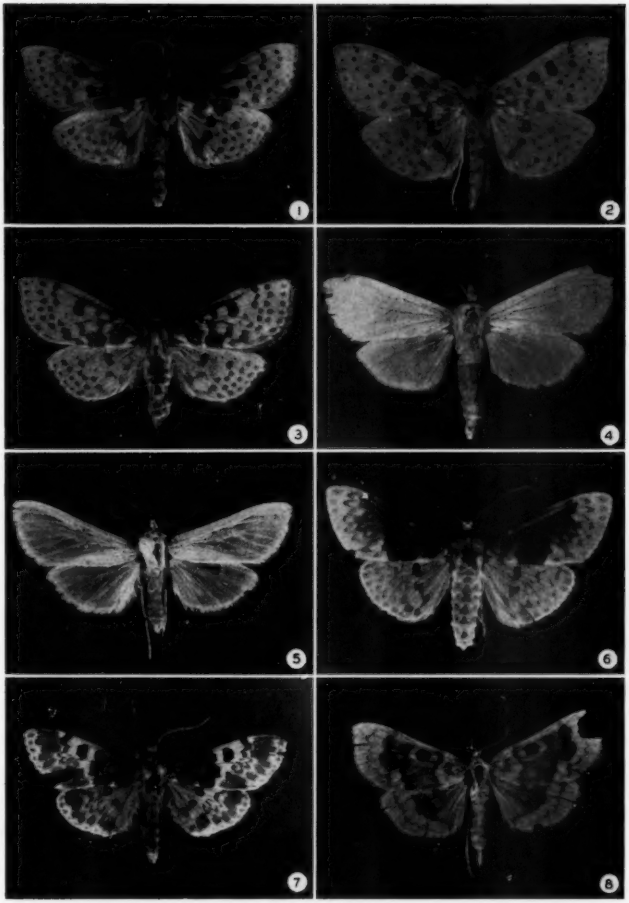
Holotype, male, and two male paratypes, Rio Vermelho, Sta. Catharina, Brazil, Nov., 1955, A. Maller; type No. 6432, Canadian National Collection.

Allotype, female, Brazil, probably Novo Bremen, Sta. Catharina, F. Hoffmann, No. 83, Carnegie Museum, Pittsburgh.

Polygrammodes pareaclealis, new species

Figs. 3, 30

Frons with a yellow median triangle, purple at sides; vertex yellow; antenna yellow, with a purple patch on mesal surface of scape; maxillary palpus purple; labial palpus rather strongly porrect, mesal surface yellow, outer surface with most of second joint and dorso-apical part of first joint purple, ventral basal region and tip, including all of third joint, yellow; tongue absent; patagium purple, dusted with yellow; tegula yellow, with purple, yellow-dusted centre; notum of thorax yellow; abdomen yellow above, with mid-dorsal triangles and anterior dorsolateral patches on each segment, coalescing in some individuals. Body beneath yellow; pectus, fore coxa and fore femur purple, fore tibia purple dusted with yellow, fore coxofemoral and femorotibial articulations yellow; mid coxa and basal part of mid femur yellow, remainder of mid femur and all of mid tibia purple on outer surface, yellow on inner surface; hind coxa and femur yellow, hind tibia purple on outer surface, yellow on inner surface; all tarsi yellow. Fore and hind wings above rich yellow with all markings purple, hind wings paler towards costa and inner margin. Fore wing with a streak a varying distance along costa and another along radius as far as postmedial band; a subbasal patch from costa to inner margin; an antemedial band, moderately narrow and a little diffuse, sometimes interrupted at veins, oblique outward from costa to Cu, thence bent weakly outward for a very short distance, then bent abruptly to run more or less perpendicularly to 2nd A, there offset a little basad, and running more or less perpendicularly to inner margin; a round spot beyond middle of cell, a subquadrate one on discocellular, both joined to stripe on radius; postmedial band composed of moderately strong spots, the first two in an outwardly oblique



Figs. 1-8. *Polygrammodes* spp.. 1, 2, *P. eaclealis,* holotype, allotype. 3. *P. pareaclealis,* holotype. 4, *P. obsoletalis,* holotype. 5, *P. flavivenata,* holotype. 6, *P. obscuridiscalis,* holotype. 7, *P. harlequinalis,* paratype. 8, *P. fenestrata,* paratype.

line, the next two perpendicular to inner margin, the next two offset outward, the following one offset inward again, the next two in cells Cu_2 and 1st A directly behind discocellular bar, the last two basad of the previous two, usually fused together, and sometimes with the corresponding elements of the antemedial band; spots before postmedial band in cells M_3, Cu_1 and sometimes in M_2; first submarginal row of spots almost as strong as postmedial band and roughly parallel to it, some of the anterior spots, especially the one in cell R_5, tending to be weakly sagittate; second postmedial row weaker, parallel to margin; fringe purple, weakly interrupted with yellow opposite veins. Hind wing with a prominent L-shaped discocellular bar, a complete or nearly complete postmedial row of spots, those of the anal area tending to be joined to form a bar, the two anteriormost spots obsolescent or obsolete in some individuals; the inner and outer postmedial rows of spots prominent and complete or nearly so; weak marginal triangles

at vein ends; fringe purple; under side yellow with cell spots and postmedial and submarginal rows repeated, but more weakly than above; costa of fore wing and a narrow marginal line on both wings purple; fringe as above.
Expanse: 48 mm.

This species closely resembles *P. eaclealis*, but differs in the following characters: colour clear yellow, not orange-yellow; outer surface of labial palpus purple, yellow-tipped, not black to apex; collar purple, not yellow; costa and radius purple-streaked, not yellow; discocellular spot of fore wing subquadrate, not round; fringe checkered with yellow, not uniform; body beneath yellow, concolorous with upper surface, not contrastingly pale; mid and hind legs relatively stout, extensively marked with purple, not slender and uniformly yellow.

Female genitalia essentially as in *P. eaclealis*, but with the sclerotized collar around the ostium proportionally smaller.

Holotype, female, and one female paratype, Prov. del Sara, Bolivia, J. Steinbach; type lot No. 84, Carnegie Museum, Pittsburgh. One female paratype, Prov. del Sara, Bolivia, 450 m., April, 1910, J. Steinbach, No. 6433, Canadian National Collection.

***Polygrammodes obsoletalis*, new species**

Figs. 4, 31

Above uniform saffron-yellow, very obscurely marked with pale pinkish-buff, hardly contrasting with the ground colour; under side rather paler yellow, but otherwise similar. Frons, vertex and tegulae a little deeper saffron. Fore wing above with costal and inner margins broadly pinkish-buff; barely discernible antemedial, postmedial and submarginal rows of rather large internervular spots, following the usual course, both postmedial and submarginal rows displaced outward in cells M_2, M_3 and Cu_1; fringe whitish; hind wing without markings, but the margin and veins a little deeper saffron. Under side with costal area of fore and hind wings pale pinkish-buff; first two or three spots of postmedial and submarginal rows present on fore wing; other markings lacking. Tarsi of all legs pale pinkish-buff on outer surface. Expanse: 55 mm.

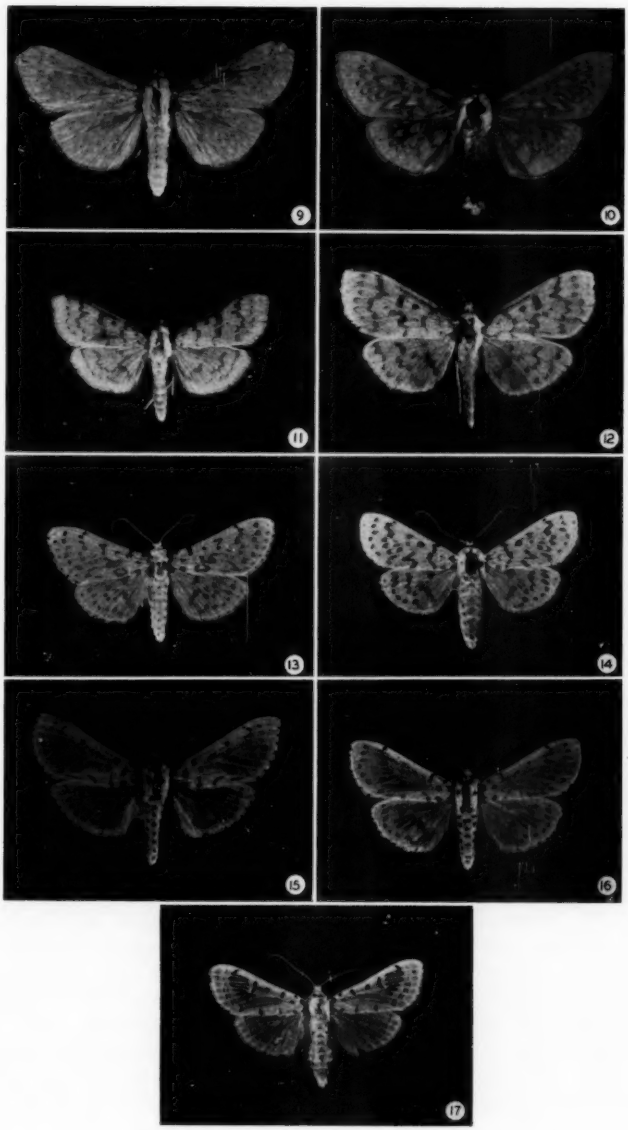
Easily recognized by the obscure pinkish markings, hardly distinguishable at first glance from the yellow ground of almost identical intensity.

Holotype, female, Boracea, Salesopolis, S.P., Brazil, April 9, 1948, L. Travassos Filho and E. X. Rabello, in the collection of the Ministry of Agriculture, Brazil, at São Paulo.

***Polygrammodes flavivenata*, new species**

Figs. 5, 19

Middle of frons, vertex, dorsum of thorax and abdomen yellow; sides of frons and a stripe from eye to wing-base wine-red; scape pale yellow, rest of antenna tan, strongly ciliated; labial palpus jet-black above, white mixed with tan below; body beneath whitish-yellow; fore coxa wine-red; fore femur pale yellow at base of inner surface and on basal half of outer surface, basal half of inner surface wine-red dorsally, remainder of inner surface black, dorsal part of middle and subterminal zones of outer surface wine-red dusted with pale yellow, ventral and terminal parts black; fore tibia black, mixed with brown and yellow scales, and with a ventral pale stripe, epiphysis walnut-brown; fore tarsal segments pale buff, tipped dorsally with black; remaining legs pale yellowish-buff. Fore wing above semi-transparent yellow, with opaque saffron-yellow veins, costal band, mid-cellular spot, discocellular bar, marginal line and fringe; hind wing above semihyaline yellow, with narrowly yellow veins and saffron-yellow mar-



Figs. 9-17. *Polygrammodes* spp. 9, *P. hyalomaculata septentrionalis*, holotype. 10, *P. hyalomaculata hyalomaculata*. 11, 12, *P. hartigi*, ♂, ♀, paratypes. 13, *P. griseinotata*, holotype. 14, *P. klagesi*, holotype. 15, *P. koepckei*, holotype. 16, *P. lichyi*, ♂, paratype. 17, *P. spectabilis*, ♂, paratype.

ginal line and fringe; wings beneath paler than above, with veins, margins and subcostal area of fore wing yellowish-buff, and with a costal stripe, small horizontal mid-cellular bar and small vertical discocellular bar fuscous-brown. Expanse: 46 mm.

Probably closest to *P. sanguifrons* Hampson, but differing in lacking transverse bands, in having the costal area uniformly pale above and uniformly fuscous, not basally red, beneath.

Holotype, male, El Limbo, Prov. Chapare, Dep. Cochabamba, Bolivia, 2,000 m., April, 1954, F. Steinbach; type No. 6435, Canadian National Collection.

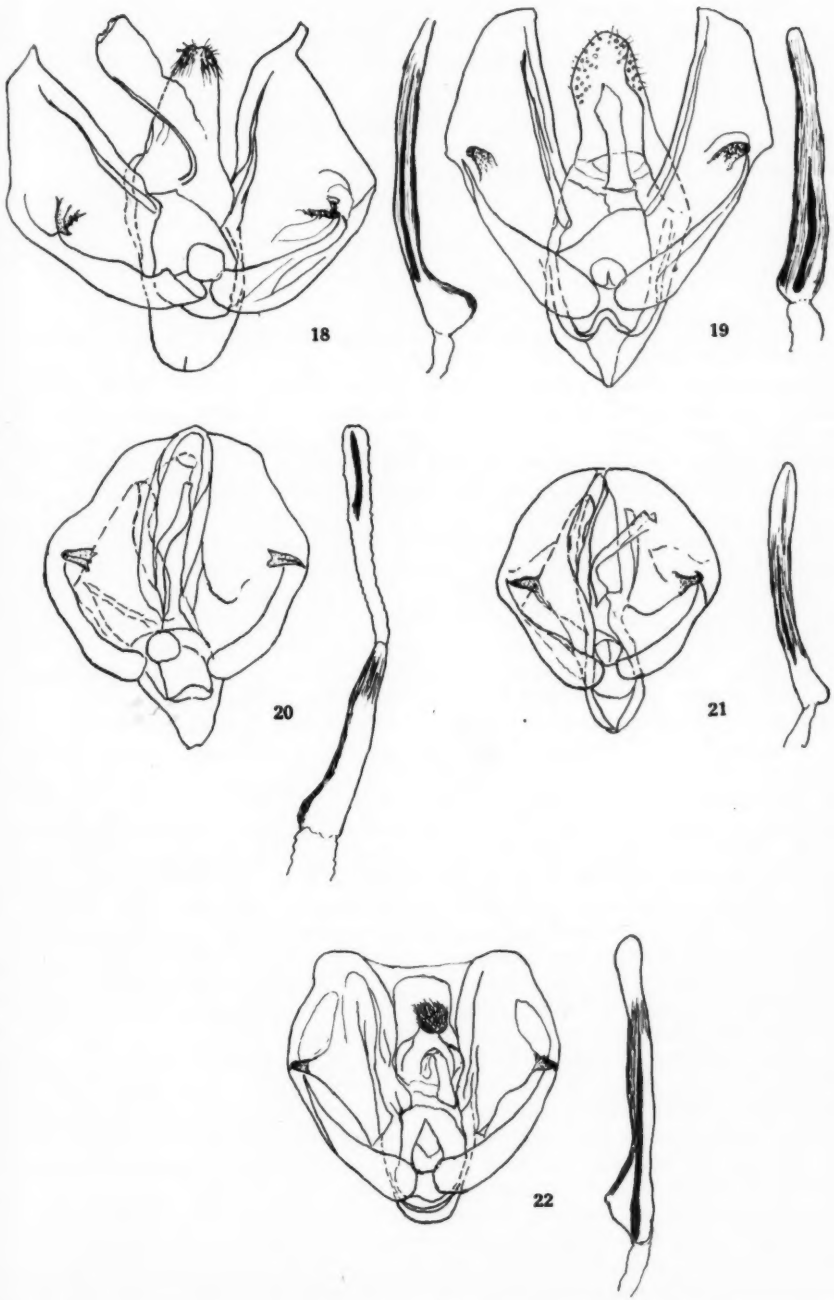
***Polygrammodes obscuridiscalis*, new species**

Figs. 6, 20

Vertex, basal segment of antenna, and a triangle on frons saffron-yellow; sides of frons, maxillary palpus, and dorsal half of labial palpus purplish-brown; ventral half of labial palpus and under side of head and body pure white; thorax above mainly purplish-brown, collar tinged anteriorly with ferrugineous, metanotum and tips of patagia orange-yellow; abdomen above orange-yellow, each segment with a central triangle and a dorsolateral quadrate patch on each side, the orange-yellow dorsal surface sharply marked off from the white ventral surface. Wings above yellow, suffused with orange, especially along veins, basal and discal areas of fore wing above almost entirely suffused with purplish-brown. Fore wing with some ferrugineous and orange-yellow in basal area, especially just before antemedial line; antemedial line obscure, purplish-fuscous, oblique outward from costa to below Cu, then upright to 2nd A, then bent inward and again outward to inner margin; an obscure purplish-fuscous spot in the cell and a purplish-fuscous bar on the discocellulars; postmedial line crenulated, forming an irregular arc from costa to M_1, there indented, and immediately bent outward to form a trilobed projection between M_2 and Cu_2, strongly retracted along Cu_2, then weakly oblique outward to above 2nd A, then inward to inner margin; inner submarginal line rather faint, purplish-fuscous, shaded inwardly with orange, roughly parallel to postmedial but more strongly crenulated, and more strongly angled on 2nd A; a faint series of submarginal purplish lunules, widest at apex; veins beyond postmedial line inconspicuously tinged with ferrugineous and bordered with orange. Hind wing with veins weakly ferrugineous and orange-bordered; a prominent dark-brown discocellular bar with a short line extending into cell from its inner edge; postmedial line weak, fuscous with some orange tints, beginning behind R_s, extending obliquely inward to M_1, thence obliquely outward to M_2, there offset outward and excurved in each of cells M_2, M_3 and Cu_1, then retracted to below angle of cell on Cu_2, and extending diffusely toward, but not to, anal angle; submarginal line similar and roughly parallel; a marginal series of fuscous patches, widest at apex; fringes of both wings orange-yellow. Under side of both wings straw-coloured, without dark or orange suffusion, with obscure dark cell-spot on fore wing, discocellular spots on fore and hind wings, a weak, interrupted postmedial band on fore wing, and traces of postmedial band on hind wing and of submarginal band on fore wing. Expanse: 48 mm.

Somewhat resembling *P. semirufa* Hampson, but larger and without the definite looped elements of the postmedial line beyond the suffused discal area of the fore wing.

Male genitalia with uncus tapered and weakly bilobed, valve moderately narrow, its outer margin strongly oblique, weakly incised below middle and angled outward before costa; penis of usual type.



Figs. 18-22. *Polygrammodes* spp., ♂ genitalia. 18, *P. eaclealis*, 19, *P. flavivenata*. 20, *P. obscuridiscalis*. 21, *P. harlequinalis*. 22, *P. hartigi*.

Holotype, male, and two male paratypes, Hyatanahan, Rio Purus, Brazil, Jan., 1922, S. M. Klages; type lot No. 85, Carnegie Museum, Pittsburgh. Two male paratypes from the same locality, type No. 6434, Canadian National Collection, presented by the Carnegie Museum.

***Polygrammodes semirufa* Hampson**

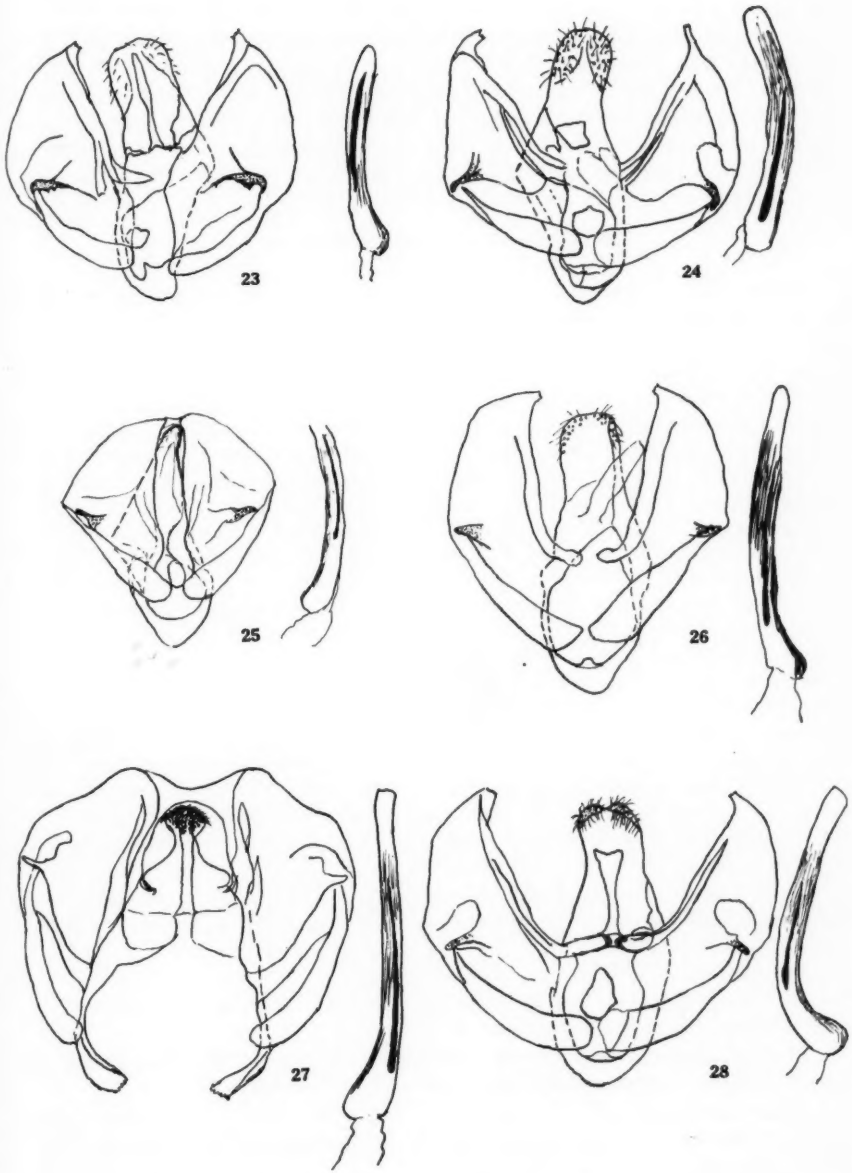
Polygrammodes semirufa Hampson, 1913: 339.
Polygrammodes basaralis Schaus, 1920: 188. New synonymy.

Schaus' description of his insect from São Paulo agrees perfectly with the good series from São Paulo and Santa Catarina states, Brazil, in the Canadian National Collection. Hampson's type, which I have seen, is also from São Paulo.

***Polygrammodes harlequinalis*, new species**

Figs. 7, 21

Head dull orange above, purple at sides; scape creamy-yellow, rest of antenna brown, short-ciliated; eye black; maxillary palpus purplish-fuscous; labial palpus rather short and blunt, purplish-fuscous above, yellowish-white below; tongue fairly well developed, cream-coloured; thorax above mainly purplish-fuscous, patagium contrastingly orange, tegula with some orange underscaling; abdomen orange-yellow, with a purplish-fuscous dorsolateral tuft on each side at base, each segment with a mid-dorsal triangle and a dorsolateral ovate patch, dull purplish; body beneath creamy-buff. Legs creamy-buff, marked as follows: fore coxa dusted with pink; fore femur and tibia dark fuscous-brown, the latter with a creamy-buff, pink-margined anterior patch; mid femur with a row of erect, pink scales on the outer surface; all tarsal segments tipped with dark fuscous-brown. Wings above orange-yellow, interspaces of hind wing somewhat paler, all markings purplish-fuscous, well-defined and contrasting. Fore wing with a large basal patch, relieved by a small, indistinct, yellow and orange patch on inner margin near base, and by a very indistinct orange antemedial line; the basal patch extending on costa and in cell to orbicular spot, almost fusing with it, in submedian cell forming a quadrate projection to almost directly behind angle of cell, somewhat retracted in anal area; orbicular spot subquadrate, solid or with middle filled with dark grey; discocellular similar but larger and somewhat elongate; postmedial line narrow but very distinct, straight or dentate from costa to M_1, there inset and straight to M_2, outbowed in cells M_2, M_3 and Cu_1 and stopping abruptly in front of Cu_2, the remainder being lost in the basal patch; small oblique marks before postmedial and tending to fuse with it, in cells M_2, M_3 and Cu_1; first submarginal band composed of large patches, in some specimens suffused with grey, fused to a varying extent, the three in cells R_4, R_5 and M_2 always at least partly fused to form a large subapical patch, the next three smaller, outwardly displaced, and often separate, the remainder fused to form a large, quadrate subtornal patch; second submarginal band consisting of an even row of small spots, close to and parallel to outer margin, regularly decreasing from apex backwards; fringe concolorous with wing. Hind wing above with a prominent ovate discocellular spot; postmedial line fused to submarginal anteriorly, oblique inward to M_1, then straight to M_2, bowed outward in each of cells M_2, M_3 and Cu_1 and preceded by small dark marks in these cells, dislocated inward on Cu_2, thence thickened and running at a slight angle distad towards the inner margin, expanding and stopping abruptly before reaching it; the two subterminal bands much as on fore wing, but narrower, the outer one incomplete posteriorly. Wings beneath dull straw colour, costal area of fore wing and outer part of that of hind wing dull purplish; cellular and discocellular spots and postmedial and submarginal bands dull fuscous, much weakened and reduced as compared with upper side. Expanse: 42 to 46 mm.



Figs. 23-28. *Polygrammodes* spp., ♂ genitalia. 23, *P. griseinotata*. 24, *P. klagesi*. 25, *P. lichyi*. 26, *P. koepckei*. 27, *P. spectabilis*. 28, *P. runicalis*.

Distinguished from other species by the dark basal area, large discocellular spots, and large, blotchy anterior and posterior spots of the inner submarginal row.

Male genitalia with uncus unusually slender, tapering, with sides incurved, tip bilobed but not expanded; valve with outer margin regularly curved, the curvature somewhat stronger towards costa; penis with cornutus rather weak.

Holotype, male, and one male paratype, Santander del Sur, Alto Rio Opon, Colombia, 900-1,050 m., Aug. 14-26, 1948, at light, L. Richter; in the Zoologische Sammlung des Bayerischen Staates. One male paratype with the same data; type No. 6436, Canadian National Collection, presented by Dr. W. Forster.

***Polygrammodes fenestrata*, new species**

Figs. 8, 32

Head above dull yellow; palpi exceptionally long, labial palpus mostly light brown, pale beneath at base; tongue well developed; patagium yellowish-brown, tegula dull yellow; body beneath light buff; fore leg light buff. Fore wing rather broad, outer margin straight to M_3, bent between M_3 and Cu_1, oblique to tornus; above with basal area brownish-yellow, bearing an indistinct purplish-brown antemedial shade, curving from costa to 2nd A; antemedial line purplish-fuscous, erect from costa to cell, oblique outward from R to 1st A, obtusely angled on fold and weakly oblique inward to margin; whole area between ante- and postmedial lines purplish-brown with some orange scaling; costal area a little paler with dark scaling along R; a round hyaline spot at middle of cell and a lunular one near end, separated by a trapezoidal dark patch; a dark double bar on either side of discocellular; dark markings in bases of cells M_2, M_3 and Cu_1; postmedial line continuous, purplish-fuscous, irregular, oblique from costa to below R_5, erect to M_2, thence excurved to M_3, then inwardly oblique to Cu_2 and retracted along Cu_2 to below lower angle of cell, thence roughly erect to margin; space between postmedial and margin clear saffron-yellow, bearing an indistinct crenulate submarginal line, roughly parallel to postmedial; fringe yellow. Hind wing with cell and costal area pale, remainder of wing purplish-fuscous to postmedial line, yellow beyond; a quadrate patch on discocellular, postmedial line narrow, dark purplish-fuscous, a little irregular but roughly parallel to outer margin; submarginal line and fringe as on fore wing; under side yellowish-buff without purplish suffusion, discal, postmedial and submarginal markings somewhat diffuse but otherwise as above. Expanse: 43 mm.

Somewhat resembling *P. hyalodiscalis* Dognin, but differing in having the outer margins of the wings subangulate between M_3 and Cu_1, not evenly rounded, in the proportionally larger hind wing, in the longer palpi, entirely pale fore leg, and in numerous details of the pattern.

Female genitalia with a simple, slender collar before ostium, ductus and bursa slender, tubular and membranous.

Holotype, female, Mexico, est. Vera Cruz, Aug. 1933, Dr. Eisenberger, in the Zoologische Sammlung des Bayerischen Staates, Munich.

Paratype, female, Mexico, Dr. Ross, 1906, "H. VI. 28;" type No. 6459, Canadian National Collection, presented by the Zoologische Sammlung des Bayerischen Staates.

***Polygrammodes hyalomaculata septentrionalis*, new subspecies**

Fig. 9

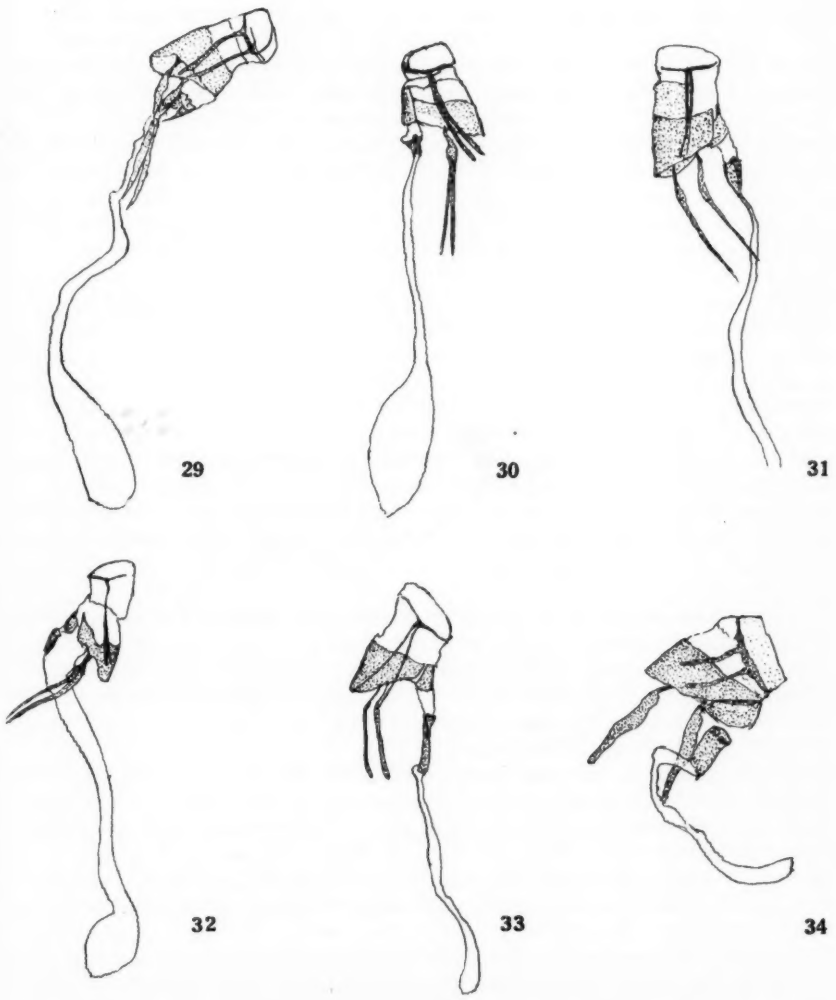
This subspecies differs from *P. hyalomaculata hyalomaculata* Dognin (Fig. 10) in having the wings paler and less yellow, with hyaline markings reduced in

extent and dark and pale markings reduced in intensity. In particular the cell spot of the fore wings is small and rounded, not larger and subquadrate as in the nominate subspecies. Structurally the two subspecies seem similar, though the palpi perhaps tend to be shorter in the present subspecies than in the nominate one.

Holotype, male, and one male paratype, Cayuga, Guatemala, Schaus and Barnes, type lot No. 89, Carnegie Museum, Pittsburgh.

One male paratype, same data; type No. 6443, Canadian National Collection, presented by the Carnegie Museum.

Specimens from Alto Rio Opon, Santander del Sur, Colombia, 900-1,050 m.,



Figs. 29-34. *Polygrammodes* spp., ♀ genitalia. 29, *P. eaclealis*. 30, *P. pareaclealis*. 31, *P. obsoletalis*. 32, *P. fenestrata*. 33, *P. hartigi*. 34, *P. spectabilis*.

W. Richter, seem referable to the present subspecies, but as this locality is considerably removed from the type locality, I exclude them from the type series.

I have seen material agreeing well with the original description of *P. hyalomaculata* from Hyutanahan, Rio Purus, Brazil, and from Kartabo, British Guiana.

***Polygrammodes hartigi*, new species**

Figs. 11, 12, 22, 33

Pachynoa flavidalis, Druce, 1895: 220, in part, Pl. 61, figs. 9, 10, err. det.

Most of frons, all of vertex and basal segment of antenna pale straw-yellow; anterior and lateral margins of frons and lateral scaling of head behind eye purple; remainder of antenna light brown; maxillary palpus and dorsal part of labial palpus dark brown; ventral part of labial palpus pale yellow; thorax above light yellow, with a purple patch at side of patagium and a diffuse mauve or purple patch on base of tegula; abdomen pale yellow above; body light yellowish-buff below; fore femur tipped with brownish-fuscous; fore tibia with base and tip brownish-fuscous; fore, mid, and in some specimens hind, tarsal segments tipped with brownish-fuscous. Wings above pale straw-yellow; fore wing with a variable amount of purple staining at extreme base and along costa as far as antemedial line. Ordinary markings brown. Fore wing in some specimens with faint traces of a subbasal line, especially a dot behind base of Cu; antemedial oblique and sometimes a little irregular to behind Cu, then angled weakly inward to below 2nd A; a dot in cell and a bar at end of cell; postmedial line upright and a little irregular to M_1, minutely but sharply toothed inward on that vein, minutely bowed outward in cells M_2, M_3 and Cu_1, there dislocated or retracted to below discocellulars, angled outward on submedian fold and erect from 2nd A to margin; submarginal row of spots faint or obsolete, close to and roughly parallel to outer margin, weakly offset on M_2. Hind wing with a weak or obsolescent discocellular bar; postmedial line beginning at R_s, running at a slight inward angle to M_1, there sharply angled outward to M_2, minutely excurved in each of cells M_2, M_3 and Cu_1, dislocated or retracted on Cu_2 to near angle of cell, thence running straight toward inner margin but ending before reaching it; submarginal line a broken and slightly irregular series of weak dashes; a narrow orange-yellow marginal line. Under side paler with markings of upper side repeated, those of fore wing somewhat stronger than above. Expanse: male, 28 to 37 mm.; female 37 to 42 mm.

This species is closely similar to *P. flavidalis*, with which it has been confused. The fore wing is narrower, with the outer margin much more rounded and a little more oblique; the hind wing is proportionally smaller; the subterminal line is much weaker than in *P. flavidalis*. The male genitalia differ most noticeably in the penis, which is of normal proportions in the present species, not exceptionally long and slender as in *P. flavidalis*.

Holotype, male, allotype, female, and a number of paratypes, Finca "La Violeta", Soconusco, Chiapas, Mexico, 850 m., various dates from July to October, 1954, No. 6437, Canadian National Collection. Paratypes from this series will be deposited in the British Museum (Natural History), London, England, in the Muséum d'Histoire Naturelle, Paris, France, in the American Museum of Natural History, New York, and in the United States National Museum, Washington, D.C.

Additional paratypes are distributed as follows:—

In the Carnegie Museum, Pittsburgh: one male, Juan Vinas, Costa Rica, Feb., Schaus (identified by Schaus as *Pionea flavidalis* Gn.); one male, Cayuga, Guatemala, May, Schaus, (identified by Schaus as *Pyrausta oxydalis* Gn.); one male, San José, Costa Rica; one male, Costa Rica, Champion; type lot No. 86.

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In the Canadian National Collection, one male, Costa Rica, Champion, presented by the Carnegie Museum.

In the Berlin Museum, one female, Chiriqui, *ex coll* Staudinger.

In the Zoologische Sammlung des Bayerischen Staates, Munich, one female, Jalapa, Mexico, May 13, 1913, J. Lane.

***Polygrammodes flavidalis oxydalis* (Guenée), new status**

Botys oxydalis Guenée, 1854: 328.

Polygrammodes oxydalis, Munroe, 1950: 224.

This species has been widely misinterpreted. The description calls for a saffron-yellow insect with ferrugineous markings on the abdomen and some black markings on the under side of the wings, expanse 30 mm. The type locality is Georgia. Specimens standing in collections as *P. oxydalis* are for the most part *P. hartigi* Munroe or the pale form of *P. ponderalis* (Guenée), neither of which occurs in the southeastern U.S.A. To judge from limited material before me, southeastern specimens of *P. flavidalis* tend to have the characteristics mentioned by Guenée and shown by his type, which I examined through the courtesy of the authorities of the United States National Museum. It is likely that the type locality is actually in a blend-zone, as material from southern Florida is even smaller and darker, but for the time being Guenée's name can be used for the general concept of the dark southeastern population.

***Polygrammodes griseinotata*, new species**

Figs. 13, 23

Frons and most of vertex yellow; sides of vertex and a stripe from behind eye to wing-base purplish-brown; scape white; antenna yellow-scaled, long-ciliated below; maxillary palpus and dorsal part of labial palpus dark fuscous; ventral part of labial palpus white; tongue fairly well developed, white; thorax and abdomen above yellow, the latter with a mid-dorsal brown dot near the posterior margin of each segment, and a pair of dorsolateral dots before the middle of each segment; body beneath white; fore coxa faintly tinged with yellow; hind leg white, tarsal segments weakly tipped with fuscous; fore and middle legs lacking in type specimen. Wings above pale lemon-yellow with grey markings, seen under the microscope to be formed of brown scales tipped with lilacine. Fore wing with a very narrow streak along extreme costal margin, reaching postmedial band; subbasal row composed of three spots, one on costa near base, one farther distal, behind cubitus, and a third a little farther distad, forming an incurved caliper-like mark between 2nd A and margin; cell-spot small, rounded; discocellular bar T-shaped; postmedial band composed of separate spots in the cells, the first two oblique outward, the next two oblique inward from the second, the next three displaced distad, weakly lunate, and preceded by dots in or near the bases of cells M_2 and M_3 and an L-shaped marking in cell Cu_1, the rest of the band displaced well basad of end of cell, consisting of large lunules between Cu and 2nd A and between 2nd A and margin; inner submarginal band roughly parallel to outer margin, a little zig-zagged, consisting of a round spot in each cell from R_1 to inner margin, except in Cu_2, where there is an oblique bar; outer submarginal band a regular row of spots close to margin, decreasing slightly in size posteriorly; a fine orange-tinted marginal line and a row of minute black terminal dots at vein-ends. Hind wing with a discocellular bar; postmedial band consisting of spots in cells R_s and M_1 in an inwardly oblique row, spots in M_2, M_3 and Cu_1 displaced distad, the last somewhat basad of the others, each preceded by a small dash near the base of the respective cell, the band displaced basad on Cu_2, but not to cell-end, the last part consisting of a bar oblique outward from Cu_2 to 2nd A, interrupted below 1st A. Expanse: 39 mm.

Differs from other members of the *runicalis* group in the attractive grey maculation on a lemon-yellow ground.

Male genitalia with uncus very broad and rounded, valve short and broad, with costal margin almost straight, apex acute, outer margin broadly rounded; juxta very small; penis hardly tapering; cornutus a little over half its length.

Holotype, male, "Colombia, South America", *ex coll.* John L. Sperry; type No. 6438, Canadian National Collection.

***Polygrammodes klagesi*, new species**

Figs. 14, 24

Most of frons and vertex yellow, sides of frons and whole occiput ferrugineous; scape white; labial palpus dorsally fuscous, ventrally pale yellow; thorax and abdomen above orange-yellow; a brown spot on middle of tegula; each abdominal segment with a black mid-dorsal dot on posterior edge and a pair of black dorsolateral dots midway between anterior and posterior edges; under side of body whitish-buff; legs whitish-buff, fore femur and tibia marked with brown, all tarsal segments ringed distally with brown. Wings opaque dull saffron-yellow, marked with black and blackish-fuscous. Fore wing with a black point at base; subbasal black dots below Cu and on inner margin; antemedial line interrupted, oblique outward from costa to R, an erect bar or pair of dots in cell, another below Cu, displaced a little distad, an inwardly oblique bar then an outwardly oblique short dash in the space between 2nd A and margin; a rather large round dot in cell, small dots at upper and lower angles of cell; postmedial line broken and irregular, a dot behind costa, an almost horizontal dash a little farther distad in cell R_4, an inwardly oblique dash in cell R_5, forming a chevron with the preceding one, a lunule in M_1, three somewhat more distally placed lunules in M_2, M_3 and Cu_1, these preceded by dashes in the bases of their respective cells, the band dislocated on Cu_2 to near the origin of that vein, a sharp chevron between Cu_2 and 2nd A, a bar between 2nd A and margin, oblique outward; first submarginal row almost regular, composed of ovate dots, tending to be divided along mid-cellular folds; the dot in cell M_1 a little elongate and displaced a little basad; second submarginal row very close to margin, obsolescent posteriorly; black marginal dots opposite vein-ends. Hind wing with an erect, somewhat diffuse discocellular bar; prominent dashes in bases of cells M_2, M_3 and Cu_1; postmedial line somewhat interrupted and jagged, erect from R_1 to M_1, oblique outward to M_2, lunate in cells M_2, M_3 and Cu_1, then dislocated basad to near angle of cell, and proceeding diffusely and somewhat obliquely to near anal margin, bending abruptly basad and petering out before attaining it; inner submarginal band well developed and fairly regular, the spots in cells M_2, M_3, Cu_1 and 2nd A set slightly distad of the others; outer submarginal band obsolescent, only the anteriormost one or two spots distinct; marginal spots as on fore wing. Wings beneath yellowish-buff, with discal and postdiscal markings of upper side repeated rather diffusely in brown. Expanse: 36 mm.

Closely similar to *P. trifolialis* Dognin, but differing in the smaller size, somewhat paler ground colour, blackish instead of lilacine-brown markings and in details of the maculation.

Male genitalia with uncus moderately wide, parallel-sided, broadly rounded at end, with a small semicircular lobe at extreme tip; valve moderately narrow, costal margin slightly humped, apex acute, outer margin oblique, rounded ventrally; juxta moderately small; penis short and comparatively stout, with a fairly long cornutus.

Holotype, male, Hyatanahan, Rio Purus, Brazil, March, 1922, S. M. Klages; type lot No. 87, Carnegie Museum, Pittsburgh. One male paratype, same locality

and collector, February, 1922; type No. 6439, Canadian National Collection, presented by the Carnegie Museum.

***Polygrammodes koepckei*, new species**

Figs. 15, 26

Vertex and most of frons saffron-yellow, frons purple at sides, an irregular purple stripe from costa to wing-base; scape yellow; antenna of male strongly biserrate, almost pectinate; labial palpus brown above, stained with purple at base, yellow beneath; thorax and abdomen above yellow, purple dots on tip of patagium, on middle of tegula, on middle of thorax and on dorsolateral basal tuft of abdomen; each abdominal segment with a mid-dorsal and a pair of dorsolateral purple dots; body beneath pale yellow; legs pale yellow, fore coxa and femur purple, fore tibia fuscous, yellow in middle, fore and mid tarsal segments tipped with fuscous, mid femorotibial joint fuscous and purple, mid femur and tibia thickened and compressed, the femur with a fringe of long scales on under side, the tibia with a small dorsal hair-tuft at base, hind femur decurved in middle, with a fringe of long scales along under side, hind tibia with a dorsal hair-tuft at base, larger than that of mid tibia. Fore and hind wing light yellow, the scales of postmedial region of fore wing and of the base and disc of hind wing tending to be fugitive, the strongly opalescent wing membrane tending to show through in these areas; all markings dark purple except the black marginal spots. Fore wing with prominent basal points on costa and in cell; base of costa narrowly black for a variable distance; subbasal dots on R, Cu, and inner margin; antemedial line broken, a dot on costa, an oblique dash in line with it in anterior part of cell, an upright dash or pair of dots below Cu, another below 2nd A, slightly incurved and slightly displaced distad; a weakly elongate dot in cell, tending to be divided along cell-axis; dots at upper and lower angle of cell; weak radiating dashes in bases of cells M_2, M_3 and Cu_1; postmedial line consisting as far as Cu_2 of lunate spots in the cells, an excurved series of four from costa to M_2, an exserted straight series of three from M_2 to Cu_2, the band dislocated to below cell on Cu_2, then forming a sharp, outward-pointed chevron to inner margin, broken at 2nd A; first submarginal row of spots almost parallel to postmedial row, less distinct, with the spots rounded, not lunate; second submarginal row obsolescent or obsolete posteriorly, often poorly developed even anteriorly; fringe silky yellow, with slender black dashes at vein-ends. Hind wing without an upright discocellular bar, but in the males with a purple dash along Cu, from origin of Cu_2 to end of cell, this dash lacking in the female; minute dashes in bases of cells M_2, M_3 and Cu_1; postmedial consisting of lunate spots in cells R_s and M_1, lunate spots set farther out in M_2, M_3 and Cu_1, and a diffuse oblique dash from Cu_2 below cell towards, but not reaching, anal angle; first submarginal row stronger than on fore wing, consisting of dots on anterior half, dashes on posterior half, weakly sinuous; second submarginal row represented by traces of one or two anterior spots, or obsolete; an orange-yellow marginal shade; fringe as on fore wing. Under side straw-coloured, with markings of upper side repeated, but weakly and with antemedial elements lacking; costal area of fore wing light purple. Expanse: male, 40 mm.; female, 48 mm.

In general appearance resembling *P. trifolialis* Dognin and *P. klagesi* Munroe, but differing in the pale yellow colour and in the thinner and evanescent sealing of parts of the wing, in having the fore coxae purple, not yellow, and in having a transverse bar on Cu or none instead of an erect discocellular bar on the hind wing.

Holotype, male, and allotype, female, Hcda. Taulis, Peru, ca. 6°50′S, 79°10′W, 1-10 May, 1954, Koepcke, in the Zoologische Sammlung des Baye-

rischen Staates, Munich. One male paratype, with the same data; type No. 6440, Canadian National Collection, kindly presented by Dr. W. Forster.

***Polygrammodes lichyi*, new species**

Figs. 16, 25

Vertex yellow; frons white, purple at sides; scape white, with an acute scale-tooth in front; labial palpus blackish fuscous above, pale yellow beneath; a stripe from eye to wing-base purple; thorax yellow above, with purplish spots at base and tip of patagium, one on middle of tegula, and a dark fuscous spot on disc of thorax; abdomen above pale yellow, with a black mid-dorsal posterior bar and a pair of black central dorsolateral spots on each segment; body beneath yellowish-white, fore femur, tibia and tarsal segments, and mid and hind tarsal segments all tipped with dark fuscous. Wings above pale yellow, thinly scaled on disc of fore wing and base and disc of hind wing; traces of orange-yellow spots in marginal area; markings slender, black. Fore wing with a distinct basal dot; a subbasal row of three spots, one ahead of Sc, one below Cu and one on inner margin; an antemedial row of five spots, one in front of Sc and one in cell, in a line perpendicular to costa, one behind Cu, offset distad from this line, and two behind 2nd A, in an inwardly oblique line from third spot to inner margin; a round spot in cell and a spot at anterior and posterior angles, tending to be connected by a weak bar along discocellular; prominent radiating dashes in cells M_2, M_3 and Cu_1, tending to fuse with elements of postmedial band in those cells; postmedial band consisting of separate spots and dashes, a spot behind costa and one in R_4 in a line oblique outwards, an inwardly oblique dash in R_5 and an outwardly oblique one in M_1, forming an incomplete V with narrow end basad; short dashes in M_2 and M_3 and a dash or sagittate mark in Cu_1, an outwardly oblique dash behind Cu_2, beginning behind posterior angle of cell and not reaching 2nd A, a short erect or oblique dash at margin; submarginal row with dots in R_4, R_5 and M_1 in a curved row, the dot in M_1 tending to be elongated into an internervular dash, dots in M_2, M_3 and Cu_1 offset distad, dot in Cu_2 offset strongly basad, forming an outwardly oblique line with that in 1st A, dot in 2nd A elongated; a row of black dots in fringe at ends of veins. Hind wing with a short black bar on discocellulars; radiating dashes in cells M_2, M_3 and Cu_1, fusing with corresponding elements of postmedial band; postmedial band beginning with inwardly converging dashes in cells R_5 and M_1, the elements in M_2, M_3 and Cu_1 recognizable as weak barbs on the dashes in those cells; an oblique dash from Cu_2 to near anal margin, bending abruptly basad and petering out just before margin; submarginal band composed of spots in cells, somewhat offset outward at M_1 and toothed inward behind Cu_2; marginal dots as on fore wing. Under side creamy-buff with a discocellular bar and the first two submarginal spots well marked, otherwise without markings except for faint dots in the fringe. Expanse: 36 to 40 mm.

Close in external appearance to *P. runicalis* Guenée, but considerably smaller and, to judge from the somewhat rubbed type series, much less brilliantly coloured; the markings certainly much more slender and less conspicuous; the scale-tooth on the scape of this species lacking in *P. runicalis; P. runicalis* with the inner surface of the fore femur and a large spot on the fore coxa purple, these areas pale in the present species.

Male genitalia with uncus tapering, bilobed at tip; valve much broader and shorter than in *P. runicalis*, with ventrodistal angle nearly a right angle; penis with cornutus proportionally smaller.

Holotype, male, Massif da Naiguata, D.F., Venezuela, 720 m., Aug. 28, 1948, R. Lichy, and one male paratype, Las Quiguas, Esteban Valley, N. Venezuela;

type No. 6441, Canadian National Collection, the paratype presented by the Carnegie Museum, Pittsburgh.

Two additional male paratypes, Altamira, S. Carabobo, Venezuela, S. M. Klages, and Las Quiguas, Esteban Valley, N. Venezuela; type lot No. 88, Carnegie Museum, Pittsburgh.

***Polygrammodes spectabilis*, new species**

Figs. 17, 27, 34

Frons and vertex smooth-scaled, white, frons more strongly rounded than in most species; labial palpus shorter than in most species, black above, white beneath; thorax above white, an orange spot on middle of patagium, another near base of tegula, a black spot in mid-dorsal line somewhat behind middle; abdomen above white, with a black transverse mid-dorsal dash near the posterior margin of each segment and a black dorsolateral dot near the anterior margin of each segment; seventh and eighth tergites stained with orange most strongly on sides, in one female the orange confined to lateral spots; body beneath white, legs white; inner surface of fore femur black; fore tibia black with a white ring before middle; all tarsal segments ringed distally with black. Wings above white with a slight nacreous lustre, markings slender, well defined, black; an even row of conspicuous orange subquadrate patches between submarginal line and margin on both fore and hind wings; fringes uniformly white. Fore wing with a basal dot on R, subbasal line of three dots, one behind costa, one below Cu, and one on inner margin; antemedial line consisting of an outwardly oblique bar or pair of dots in cell, an almost erect, slightly outwardly oblique bar from Cu to 2nd A, offset well distad from cell-bar, and a slightly inwardly oblique bar, inset a little from the previous one, from 2nd A to margin; a round spot in cell and a straight or weakly curved one in discocellulars; three radiating dashes in bases of cells M_2, M_3 and Cu_1, that in Cu_1 obsolete in some specimens; postmedial arising just behind costa, weakly indented on R_4, very strongly retracted on each of veins R_5, M_1 and M_2, returning to the level of origin in each interspace, so that this part of the line is very strongly sinuated, a strong dislocation distad on M_2, the band forming a series of three inward-staggered erect dashes in cells M_2, M_3 and Cu_1, close to and parallel to submarginal line, the line then dislocated to below cell, forming an outward-pointed chevron between Cu_2 and 2nd A, and an outwardly oblique dash from 2nd A to margin; postmedial line fairly even, interrupted at veins to form a series of bars in the cells, dislocated a little distad in cells M_2, M_3 and Cu_1, appearing doubled in these cells because of the approximation of elements of postmedial, as already described, the bar behind Cu_2 oblique outward, a trace of a dot behind 2nd A in some specimens. Hind wing with a dot or short bar on discocellular, and a dot or bar on lower margin of cell between origins of Cu_1 and Cu_2; dashes in the bases of cells M_3 and Cu_1; an interrupted postmedial line beginning behind R_s, excurved at M_2, retracted and broken at Cu_2, thence represented by one or two dots in a line to margin; submarginal line interrupted at veins, nearly parallel to outer margin, slightly indented at Cu_2. Under side white, with most of markings of upper side weakly repeated. Expanse: male, 33 to 39 mm.; female, 37 to 44 mm.

Somewhat similar to *P. hermineallis* Schaus in its general aspect, but differing in lacking orange markings at base and in cell, in the violently sinuate postmedial line, in lacking dark grey spots in the fringe, in having the tip of the abdomen orange, and in other details.

Male genitalia: uncus constricted in middle, tip expanded and dorsally spinose; valve with apex rounded, ventral angle with a rounded lobe; aedoeagus with one

wall sclerotized strap-wise; cornutus straight, more than three-fourths length of penis.

Female genitalia: ovipositor lobes and eighth segment rather heavy; apophyses short and broad; collar around ostium large, simple, not very heavily sclerotized; ductus membranous, bursa hardly wider than ductus.

Holotype, male, allotype, female, and two male and one female paratypes, Prov. del Sara, Bolivia, 450 m., J. Steinbach; type lot No. 89, Carnegie Museum, Pittsburgh.

Two male and one female paratypes, same data, type No. 6442, Canadian National Collection, presented by the Carnegie Museum.

Polygrammodes maccalis (Lederer), new combination

Botys maccalis Lederer, 1863: 371, 466, Pl. 9, Fig. 14.
Pachynoa? maccalis, Hampson, 1896: 397.
Polygrammodes eximia Jones, 1921: 355, Pl. I, Fig. 6. New synonymy.

There seems no doubt that Lederer's figure represents this insect, despite the erroneous type locality Silhet. It is not uncommon in southern Brazil; I have seen a number of specimens from the states of São Paulo and Santa Catarina; the type locality of *P. eximia* is Alto da Serra, Santos.

Polygrammodes runicalis Guenée

Fig. 28

The genitalia I figured in an earlier paper (Munroe, 1950, Fig. 6) belonged not to this species but to the closely related *P. arpialis* Schaus. *P. arpialis* is distinguished by the slightly broader and less acute wings, by the less strongly contrasting yellow terminal area, and particularly by the elements of the post-medial band in cells M_2, M_3 and Cu_1 of the fore wing: these elements are strongly sagittate, and when they join with the radiating dashes in the bases of the same cells they form a strongly hooked marking, not an entire or weakly barbed dash as in *P. runicalis*. I have before me good series of both species from southern Brazil, and there is no doubt they are distinct. I figure the genitalia of *P. runicalis* (Fig. 28).

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References

Druce, H. 1895. Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera, Signature 2ff. London.

Hampson, Sir G. F. 1896. The fauna of British India. Moths.—Vol. IV. London.

Hampson, Sir G. F. 1913. Descriptions of new species of Pyralidae of the subfamily Pyraustinae. *Ann. Mag. Nat. Hist.* (8) 11: 322-342.

Jones, E. D. 1921. Descriptions of new moths from south-east Brazil. *Proc. Zool. Soc. London* 1921, pp. 323-356; Pl. 1-3.

Guenée, A. 1854. Spécies général des Lépidoptères. Tome huitième. Deltoides et Pyralites. Paris.

Lederer, J. 1863. Beitrag zur Kenntniss der Pyralidinen. *Wien Ent. Monatschr.* 7: 331-502, Pl. 2-18.

Munroe, E. 1950. The generic positions of some North American species commonly referred to *Pyrausta* Schrank (Lepidoptera: Pyralidae). *Can. Ent.* 72: 217-231.

Schaus, W. 1920. New species of neotropical Pyraustinae (Lepid.). *Proc. Ent. Soc. Washington* 22: 172-190.

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Notes on Occurrence of *Typhlodromus* and *Phytoseius* spp. in Southern British Columbia (Acarina: Phytoseiinae)[1]

By N. H. Anderson[2], C. V. G. Morgan[3], and D. A. Chant[2]

Phytoseiid mites are of cosmopolitan interest because they are predacious on many phytophagous mites (Tetranychidae, Eriophyidae, and Tarsonemidae) that are pests of agricultural crops. They have been studied in orchards (Collyer, 1953, 1956; Lord, 1949), vineyards (Mathys, 1955), citrus groves (Fleschner and Ricker, 1954; Muma, 1955), and strawberry plantings (Huffaker and Kennett, 1953, 1956), but few workers have recorded their presence in native environments. In the commercial fruit-growing areas of British Columbia, orchards are often planted near uncultivated areas of bush or grassland. The study on which these notes are based was undertaken to determine whether the phytoseiids that occur in these native sites become established in the orchards, and to obtain a knowledge of the entire phytoseiid fauna of the area, a necessary prerequisite to ecological studies of predacious mites in orchards.

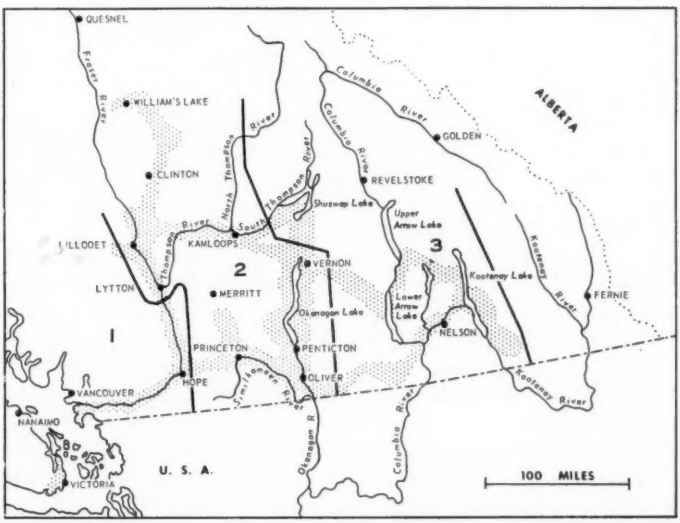

Fig. 1. Areas in southern British Columbia from which phytoseiids were collected, 1951-56.

The areas from which phytoseiids were collected in southern British Columbia can be roughly divided into three climatic regions from west to east (Fig. 1): the wet Pacific coastal areas, including the lower Fraser Valley; the dry interior (Similkameen Valley, Okanagan Valley, and southern Cariboo); and the moist districts of the Kootenay Valley and Arrow lakes. These regions are designated 1, 2, and 3 respectively. Collections were taken from Victoria in the west to Kitchener in the east, and from the Canada-United States boundary north to Williams Lake. Except in the Okanagan Valley and Arrow lakes regions the collection sites were usually near main highways or good secondary roads.

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Three techniques were used to collect specimens: direct removal from foliage with a dissecting needle or a camel's-hair brush; collecting from a counting disc after the leaves were brushed with a Henderson and McBurnie brushing machine (Henderson & McBurnie, 1943); and collecting the mites in a vial attached to the neck of a screened funnel over which branches and foliage were beaten.

The species collected are listed below. Brief notes are given on their geographical distributions and the plants from which they were collected. The species marked with an asterisk occur on apple or other fruit trees, or both.

Genus *Typhlodromus* Scheuten, 1857
Subgenus *Typhlodromus* Scheuten, 1857

T. (*T.*) *arboreus* Chant, 1957*.—Rare in 1, but common in 2 and 3. Collected from plum; apple; juniper, *Juniperus* sp.; Douglas fir, *Pseudotsuga taxifolia* (Poir.) Britton; western white pine, *Pinus monticola* Dougl.; and birch, *Betula* sp.

T. (*T.*) *bakeri* (Garman, 1948)*.—Abundant in 1 (Vancouver) and also recorded from 3 (Kootenay Bay, Burton, and Fosthall). Collected from apple; cherry; plum; western white pine; and lodgepole pine, *P. contorta* Dougl. var. *latifolia* Engelm. Primarily a bark inhabiting form.

T. (*T.*) *conspicuus* (Garman, 1948)*.—Rare. Collected in 1 (Langley) on apple and in 2 (Osoyoos) on mock orange, *Philadelphus lewisii* Pursh, and bracken, *Pteridium* sp.

T. (*T.*) *flumenis* Chant, 1957.—Rare. Collected in 2 (Hedley) on soopolallie, *Shepherdia canadensis* Nutt., and in 3 (Fosthall) on western white pine.

T. (*T.*) "new species" (see Cunliffe and Baker, 1953)*.—Rare in 1, locally common in 2. Collected on apple; peach; red osier dogwood, *Cornus stolonifera* Michx.; Douglas fir; and spirea, *Spiraea* sp.

T. (*T.*) *occidentalis* Nesbitt, 1951*.—The most common species on orchard trees in 2. Not common in 1 or 3. Collected on a wide variety of deciduous trees and herbaceous plants, and also on dwarf juniper, *Juniperus communis* L.

T. (*T.*) *pini* Chant, 1955.—Locally abundant in 1 at Vancouver on western white pine and lodgepole pine and at Victoria on arbutus, *Arbutus menziesii* Pursh. Collected in 2 and 3 on ponderosa pine, *Pinus ponderosa* Laws.; bracken; and western white pine.

T. (*T.*) *rhenanus* (Oudemans, 1905)*.—The most widely distributed species. Abundant in all areas. Usually found on deciduous trees, rarely on herbaceous plants. Not collected from evergreens.

T. (*T.*) *singularis* Chant, 1957.—Collected only in 2 and 3 on western white pine; ponderosa pine; lodgepole pine; Douglas fir; western red cedar, *Thuja plicata* Donn; Englemann spruce, *Picea engelmannii* Parry; juniper; black cottonwood, *Populus trichocarpa* Torr. & Gray; trembling aspen, *Populus tremuloides* Michx.; willow, *Salix* sp.; Douglas maple, *Acer glabrum* Torr. var. *douglasii* (Hook.) Dipp.; sumac, *Rhus glabra* L.; and mock orange.

T. (*T.*) *soleiger* (Ribaga, 1902)*.—Common in 2 on alder, *Alnus* sp.; birch; lodgepole pine; black cottonwood; and trembling aspen but rare on apple. Collected in 1 at Langley on red currant, *Ribes vulgare* Lam., and at Hope on alder.

T. (*T.*) *tiliae* Oudemans, 1929*.—Abundant in 1 on a wide variety of plants, including deciduous trees and low growing plants. On hazel, *Corylus* sp., in one locality in 2 (Summerland).

T. (*T.*) *validus* Chant, 1957.—Rare. Collected only in 2 (Oliver and Keremeos) on wild cherry, *Prunus* sp.; black cottonwood; and ponderosa pine.

Subgenus *Amblyseius* Berlese, 1914

T. (*A.*) *aberrans* Oudemans, 1930 (=*vitis* Oudemans, 1930, and *Kampimodromus elongatus* (Oudemans, 1930)).–Rare. Collected only in 1 (Rosedale) on hazel.

T. (*A.*) *andersoni* Chant, 1957*.–Locally common in 1 (near Rosedale) on apple; prune; alder; and thimbleberry, *Rubus parviflorus* Nutt.

T. (*A.*) *berlesei* Chant, 1957.–Locally common in 1 and 3, rare in 2. On buttercup, *Ranunculus* sp.; thimbleberry; red osier dogwood; and birch.

T. (*A.*) *cucumeris* Oudemans, 1930.–Abundant in 2 but only on low-growing herbaceous plants and juniper.

T. (*A.*) *desertus* Chant, 1957.–Locally common in 2 at Oliver on black cottonwood and willow and at Hedley on willow.

T. (*A.*) *fallacis* (Garman, 1948)*.–Common in 2 (Summerland and Kaleden) on apple, peach, cherry, and grass. Recorded in 3 (Creston) on strawberry.

T. (*A.*) *finlandicus* (Oudemans, 1915)*.–Rare. Collected only in 1 (Langley and Ladner) on apple.

T. (*A.*) *fraterculus* (Berlese, 1914)?.–One male specimen collected in 2 (near Oliver) on decaying apple stump.

T. (*A.*) *marinus* (Willmann, 1952).–Rare. Collected only in 2 (Penticton) on strawberry roots. This must be ecologically very dissimilar to the species collected in salt marshes in northern Germany by Willmann (1952), but morphologically they are identical.

T. (*A.*) *masseei* Nesbitt, 1951.–Rare. Collected only in 1 (Langley) on red currant and in 3 (Edgewood) on thimbleberry.

T. (*A.*) *morgani* Chant, 1957.–Locally common in 2 (Summerland) on dandelion, *Taraxacum officinale* Weber.

T. (*A.*) *obtusus* (Berlese, 1914) (ex Koch)*.–Locally common in 2 (Summerland) on apple and grass.

T. (*A.*) *okanagensis* Chant, 1957*.–Locally common in 2 (Summerland) on apple; peach; and burdock, *Arctium lappa* L.

T. (*A.*) *perlongisetus* (Berlese, 1914).–Rare in 2 and 3. Collected on birch and wild gooseberry, *Ribes* sp.

T. (*A.*) *reticulatus* Oudemans, 1930.–Two specimens collected in 2 (near Summerland) on wild gooseberry.

Genus *Phytoseius* Ribaga, 1902

P. macropolis (Banks, 1909) (=*spoofi* (Oudemans, 1915))*.–The commonest species in 3. Also abundant in the northern parts of 2 and near Princeton. Not found in Okanagan Valley south of Enderby or in 1. On a wide range of native plants, primarily shrubs, but also on apple, plum, birch, Englemann spruce, willow, and lodgepole pine.

Discussion

Twenty-eight species of phytoseiids have been found in southern British Columbia but, as extensive collecting has been done only in the Okanagan Valley, further collections will undoubtedly reveal other species and extend our knowledge of geographical distributions and of the plants inhabited. Many of the species are now known from only a few specimens. Fourteen of the 28 species have been collected in orchards but only three, *T.* (*T.*) *occidentalis*, *T.* (*T.*) *rhenanus*, and *P. macropilis*, occur in relatively large numbers. These are also common on native flora.

Most of the species appear to be restricted in geographical distribution. Only five, *T.* (*T.*) *rhenanus*, *T.* (*T.*) *occidentalis*, *T.* (*T.*) *pini*, *T.* (*T.*) *arboreus*, and *T.* (*A.*) *berlesei*, have been collected in all three regions. Twenty-three species occur in the Okanagan Valley and southern Cariboo, 14 in the Pacific coastal areas and in the Fraser Valley, and 12 in the Kootenay Valley and Arrow lakes district. A number of species were found only in the Okanagan and subsidiary valleys: this restricted geographical distribution may possibly be associated with the semi-arid conditions and the plant species of this region. In general, these plants have either very small and inhospitable or large and leathery leaves, and mites may require precise adaptations to develop on them. On the other hand, some species are almost completely confined to the regions with high rainfall where succulent plants thrive; examples of these are *T.* (*T.*) *bakeri*, *T.* (*T.*) *tiliae*, and *P. macropolis*. These species are rarely encountered in the dry regions of the interior.

Species in the subgenus *Typhlodromus* favour woody plants, whereas members of the subgenus *Amblyseius* prefer herbaceous plants. Of the 12 species in the subgenus *Typhlodromus* recorded from British Columbia, only *T.* (*T.*) *occidentalis* has been found on herbaceous plants. On the other hand, nine of the 15 species in the subgenus *Amblyseius* were collected on these plants. In the Okanagan Valley the species complex on grasses and other low-growing plants in orchards is usually quite different from that occurring in the trees. Therefore, a cover crop does not serve as a reservoir for the species found in fruit trees. For example, *T.* (*A.*) *cucumeris* is abundant on the cover crops of many commercial orchards but is not found on the foliage of the trees. Conversely, the species found in orchard trees are rarely collected from cover crops. However, many of the species found on fruit trees are common on native shrubs and trees. These plants may be a reservoir of predacious mites for fruit trees, but unfortunately such plants do not commonly occur near orchard land.

The phytoseiids found in the Okanagan Valley usually occur only in small numbers. By contrast, in southeastern England fewer species have been recorded than in British Columbia (Chant, 1956; Collyer, 1956) but almost without exception these occur in greater abundance.

Acknowledgments

We wish to thank Mr. A. F. Hedlin, Forest Biology Laboratory, Victoria, British Columbia, for specimens collected in the forests of the Upper Arrow Lake region.

References

Banks, N. 1909. New Canadian mites. *Proc. Ent. Soc. Washington* 11: 133-143.

Berlese. 1914. Acari nuovi. *Redia* 10: 113-150.

Chant, D. A. 1955. Notes on mites of the genus *Typhlodromus* Scheuten, 1857 (Acarina: Laelaptidae), with descriptions of the males of some species and the female of a new species. *Canadian Ent.* 87: 496-503.

Chant, D. A. 1956 Some mites of the subfamily Phytoseiinae (Acarina: Laelaptidae) from southeastern England, with descriptions of new species. *Canadian Ent.* 88: 26-37.

Chant, D. A. 1957. Descriptions of some phytoseiine mites (Acarina: Phytoseiinae). Part I. Nine new species from British Columbia with keys to the species of British Columbia. Part II. Redescriptions of eight species described by Berlese. *Canadian Ent.* 89: 289-308.

Collyer, E. 1953. Biology of some predatory insects and mites associated with the fruit tree red spider mite (*Metatetranychus ulmi* (Koch)) in southeastern England. IV. The predator-mite relationship. *J. Hort. Sci.* 28: 246-259.

Collyer, E. 1956. Notes on the biology of some predacious mites on fruit trees in southeastern England. *Bull. Ent. Res.* 47: 205-214.

Cunliffe, F., and E. W. Baker. 1953. A guide to the predatory phytoseiid mites of the United States. *Pinellas Biol. Lab. Pub.* No. 1.

Fleschner, C. A., and D. W. Ricker. 1954. Typhlodromid mites on citrus and avocado trees in southern California. *J. Econ. Ent.* 47: 356-357.
Garman, P. 1948. Mite species from apple trees in Connecticut. *Connecticut Agr. Expt. Sta. Bull.* 520.
Henderson, C. F., and H. V. McBurnie. 1943. Sampling techniques for determining populations of the citrus red mite and its predators. *United States Dept. Agr. Circ.* 671.
Huffaker, C. B., and C. E. Kennett. 1953. Developments toward biological control of cyclamen mite on strawberries in California. *J. Econ. Ent.* 46: 802-812.
Huffaker, C. B., and C. E. Kennett. 1956. Experimental studies on predation: predation and cyclamen-mite populations on strawberries in California *Hilgardia* 26: 191-222.
Lord, F. T. 1949. The influence of spray programs on the fauna of apple orchards in Nova Scotia. III. Mites and their predators. *Canadian Ent.* 81: 202-230.
Mathys, G 1955. Etude faunistique des acariens des pommiers en Suisse Romande. *Ann. Agr. Suisse* 56: 815-825.
Muma, M. H. 1955. Factors contributing to the natural control of citrus insects and mites in Florida. *J. Econ. Ent.* 48: 432-438.
Nesbitt, H. H. J. 1951. A taxonomic study of the Phytoseiinae (Family Laelaptidae) predacious upon Tetranychidae of economic importance *Zool. Verh.* 12.
Oudemans, A. C. 1905. Bizonderheden over bekende en niewe Acari. *Tijdschr. Ent.* 48. 77-81.
Oudemans, A. C. 1915. Acarologisch aanteekeningen 56. *Ent. Ber.* 4: 180-188.
Oudemans, A. C. 1929. Acarologisch aanteekeningen 99-100. *Ent. Ber.* 8: 11-36.
Oudemans, A. C. 1930. Acarologisch aanteekeningen 105. *Ent. Ber.* 8: 48-99.
Ribaga, C. 1902. Gamasidi planticoli. *Riv. Pat. veg.* 10: 175-178.
Willmann, C. 1952. Die Milbenfauna der Nooseeinsel Wangerooge. *Verhöff Inst. Meeresforsch. Bremerhaven* 1: 146.

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Dispersal of an Insect Parasite Over a Small Plot[1]

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The relation of host density to reproduction of the chalcid parasite *Dahlbominus fuscipennis* (Zett.) was examined in a previous study (Burnett, 1954). When the parasite searched in a naturally varying physical environment for hosts –cocoons of sawflies that attack conifers–distributed over plots on a grass lawn, the influence of host density on parasitism was similar to that obtained in laboratory experiments. As the irregularities of the meteorological factors did not appreciably alter the relation of parasitism to host density it was of interest to determine whether the additional discontinuities of a natural environment would.

It was assumed that the distribution of parasite progeny among their hosts would be regulated by two processes: the distribution of the adult female parasites would be determined by biotic and related physical irregularities of the test plot; and variations in the density of the host would influence the reproductive rate of those parasites that were present in any given area. For this reason the host cocoons were exposed simultaneously to the parasite in two arrangements: (a) a uniform distribution of hosts that would indicate the differential dispersal of the parasite females; and (b) a distribution in which different densities of hosts were exposed and whose incidence of parasitism would result from parasite dispersal and host density.

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TABLE I
Parasitism of *Neodiprion lecontei* by *Dahlbominus fuscipennis* in three experiments in a small plot

	Experiment I	Experiment II	Experiment III
Number of parasites released	20,000	20,000	14,000
Number of cocoons exposed	1,660	732	732
Area of each tray, square inches	50	144	144
Air temperature, °F	49–75	46–74	38–80
Rain	No	No	Yes
Number of cocoons parasitized	586	247	169
Number of parasite eggs laid	16,525	8,735	4,238

Materials and Methods

The experimental plot, which was 24 feet square, was laid out at the laboratory field station. The flora consisted preponderantly of red pine, with some oak, poplar, birch, ferns, and grasses. Sixteen points were selected on this plot in a 4-by-4 pattern. Cocoons of *Neodiprion lecontei* (Fitch), in which the mature larvae were paralyzed by soaking in hot water, were distributed uniformly over the surface of damp moss in square, wire-mesh trays each with the top covered with wire screening. In each experiment, 16 trays containing the same number of cocoons, to serve as controls, were placed on the plot, one at each point. Sixteen trays, with four different numbers of cocoons, were distributed in a latin square beside these. In the various experiments, the number of parasites liberated, the number of hosts exposed, and the areas of the experimental trays were varied. The distribution of host densities was altered in each experiment by using a different latin square.

Each experiment was begun by releasing females of *D. fuscipennis* at the centre of the experimental plot. These females were 24-48 hours old. Twenty-four hours later the host cocoons were exposed. Seventy-two hours after exposure the cocoons were collected and the number of parasite eggs that each contained was determined by dissection.

Results and Conclusions

Most of the experiments, which were conducted throughout the summer, were discarded because parasitism was erratic and at a very low level. This reduction in the number of hosts attacked was a result of high temperatures, excessive rainfall, and, on two occasions, predation by birds. Parasitism was sufficiently high, because of moderate temperatures and the absence or the slight amount of precipitation, to be of use in three experiments; the numbers of parasites released and the areas of the trays containing the host cocoons are given in Table I for these three experiments, and the densities of the host are given in Table II.

Table I indicates that about one-third or fewer of the hosts were parasitized in spite of the very high parasite density. This is apparently in agreement with the observation of Reeks (1953) that the parasite is not directly attracted to the sawfly cocoons from a significant distance. The number of eggs deposited was always less than the number of parasites released, and so the parasites decreased in numbers from one generation to the next.

TABLE II

Parasitism by *Dahlbominus fuscipennis* when cocoons of *Neodiprion lecontei* were distributed in different densities in a small plot

Number of hosts exposed per tray		Number of hosts parasitized per tray		Number of parasite eggs laid per tray	
Control	Experimental	Control	Experimental	Control	Experimental
Experiment I					
49.....	9	20.3	7.8	538	270
49.....	25	20.8	15.0	689	604
49.....	64	20.5	23.0	603	585
49.....	121	14.0	25.3	311	532
Experiment II					
16.....	4	8.8	1.8	283	55
16.....	9	7.3	5.3	434	158
16.....	25	6.0	7.8	293	167
16.....	81	6.8	18.3	223	392
Experiment III					
16.....	4	5.5	1.8	135	61
16.....	9	9.0	3.8	225	119
16.....	25	3.8	6.3	72	151
16.....	81	3.8	8.5	97	201

Examination of the control trays indicated that, at the lower levels of parasitism in Experiments II and III, there was a slight tendency for: (a) the host nearest the point of parasite release to be more heavily parasitized than the remainder, and (b) parasitism, although recorded at all 16 points, to be slightly higher in one direction. Many of the control groups of cocoons alongside hosts at the lower densities had a higher incidence of parasitism than had those associated with the higher host densities (Table II, columns 3 and 5). The parasite appears to have dispersed very slowly, even in the absence of hosts, over the small experimental plot, to have dispersed throughout the plot in spite of the heterogeneity of the environment, and to have been attracted to the higher host densities over an area of one or two square feet.

Column 4 of Table II suggests that the number of hosts parasitized increased with host density. The number of eggs laid per tray also tended to increase with host density in Experiments II and III but not in Experiment I (column 6). The percentage of cocoons parasitized (calculated from columns 2 and 4), however, tended to decrease with host density, particularly in Experiments I and III. The F ratios obtained by an analysis of variance of the experimental results were not greatly altered by adjustments for variation in the control trays. Therefore an analysis of variance was made for those trays in which the density of the host was varied. The number of cocoons parasitized increased significantly ($P<0.01$) with host density only in Experiment I; the percentage of cocoons parasitized decreased significantly ($P<0.01$) only in the same experiment.

Though Table II indicates that the general trend of parasitism varied with host density, most of the individual tests were not significant. The F ratios were combined (Snedecor, 1956, p. 216) to assess, by means of the chi-square test, the evidence of all three experiments. For the number of cocoons parasitized, P was less than 0.01, indicating a significant positive relationship between host density and numbers of hosts attacked. The density means of eggs deposited did not follow any distinct trend and therefore these probabilities were not combined.

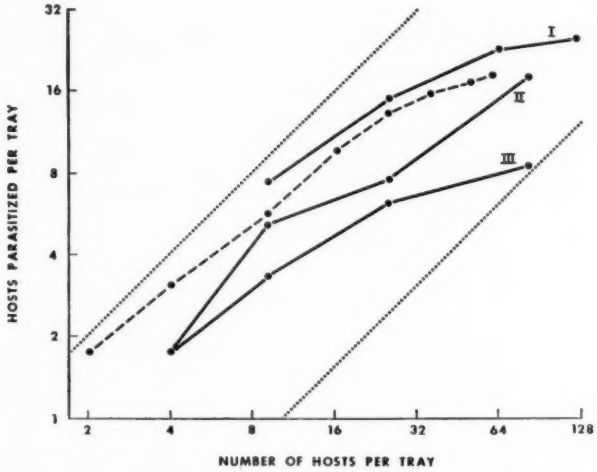

Fig. 1. Relation of parasitism to host density in field and laboratory experiments. Solid lines: experiments I, II, and III. Broken line: laboratory experiment (Burnett, 1951, Table 4) in which *D. fuscipennis* searched for cocoons of *Neodiprion sertifer*. Dotted lines: upper, 100 per cent parasitism; lower, 10 per cent parasitism.

For the percentage parasitism, P was less than 0.02, indicating a significant negative relationship between percentage parasitism and host density.

A further test for a trend in the relationship of hosts parasitized to hosts exposed was made by separating the sum of squares attributable to host density into components for linear regression and deviations from regression. A linear regression accounted for a large portion (82, 97, and 82 per cent) of the density sum of squares. The F ratios for the regression was significant at the one per cent level in Experiment I and nearly so in Experiment II. For the three approximate probabilities combined, P was less than 0.01, indicating that the number of hosts parasitized was related to the number of hosts exposed.

A comparison of the relation of hosts parasitized to hosts exposed in these field experiments and in a laboratory test is shown in Fig. 1 where the absicissa and ordinate are drawn on a logarithmic scale. Other laboratory tests (Burnett, 1951, Fig. 2) gave the same trend in parasitism as that shown in Fig. 1. In Fig. 1 the numbers of hosts parasitized are not directly comparable as the numbers of hosts exposed, the numbers of parasites searching, the areas of search, and such factors as temperature, humidity, and light varied in the four experiments. However, the trend in the field was similar to that observed in the laboratory because (a) there was a positive relationship between hosts parasitized and host density in both cases, (b) progressive increases in host density resulted in progressively smaller increases in parasitism in both cases, and (c) the percentage of hosts parasitized decreased with increase in host density in both cases.

Reeks (1953) examined effects of host density on percentage parasitism by *D. fuscipennis* when the parasite was attacking natural populations of the sawfly *Diprion hercyniae* (Htg.). There were, of course, factors other than host density that influenced host-parasite interactions but it is noteworthy that the percentage parasitism was negatively related to host density. In addition, the

parasite was successful on high host populations (up to 20 cocoons per square foot) and required a cocoon population of over one per square foot for effectiveness. The densities of the host found in nature were lower than those used in the present experiments but the plots were much larger. Table II indicates the increase in parasitism that resulted from a twentyfold increase in host density. The increase in the number of hosts parasitized would have been relatively greater if the general level of host density had been lower.

Within certain meteorological limitations, the number of hosts parasitized and the percentage of parasitism were related to host density when *D. fuscipennis* dispersed through a controlled host distribution in an otherwise natural environment. It is not surprising that the reproduction of the parasite was not as closely related to host density because oviposition of insect parasites is exceptionally sensitive to subtle environmental influences. The relation of host density to the incidence of parasitism in the laboratory experiments gave some indication of the manner in which this single factor operates in a nearly natural environment, and these preliminary experiments justify further investigation on the influence of meteorological agencies on the interaction of host and parasite populations.

Acknowledgment

The technical assistance of Mr. G. D. Williamson is gratefully acknowledged.

References

Burnett, T. 1951. Effects of temperature and host density on the rate of increase of an insect parasite. *American Nat.* 85: 337-352.

Burnett, T. 1954. Influence of natural temperatures and controlled host densities on oviposition of an insect parasite. *Physiol. Zool.* 27: 239-248.

Reeks, W. A. 1953. The establishment of introduced parasites of the European spruce sawfly (*Diprion hercyniae* Htg.)) (Hymenoptera: Diprionidae) in the Maritime Provinces. *Canadian J. Agr. Sci.* 33: 405-429.

Snedecor, G. W. 1956. Statistical methods. 5th ed. The Iowa State College Press, Ames, Iowa.

Two New Nearctic Species of *Spilomyia* (Diptera: Syrphidae), with a Note on the Taxonomic Value of Wing Microtrichia in the Syrphidae[1]

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Three species of *Spilomyia* from western North America have been in the Canadian National Collection under the name *Spilomyia interrupta* Williston, 1882. Two of these are described below as new. Through the co-operation of Mr. Paul Arnaud, then of the U.S. National Museum, I examined the two female syntypes of *interrupta* and four other specimens of the group. One syntype, labelled "W.J.; Acc. 19702, Williston; Type No. 875, U.S.N.M.; *Spilomyia interrupta* Will." on four labels is hereby designated as lectotype; it has been so labelled. The other syntype is a specimen of the species described below as *Spilomyia citima* n.sp. The other four specimens in the U.S.N.M. are all of *interrupta*: 1 ♂, Hopland, Calif., Sept.; 1 ♂, Mountains near Claremont, Calif.; 1 ♀, Tuolumne, Calif.; 1 ♀, Medford, Oreg. The C.N.C. contains two specimens of *interrupta*: 1 ♂, Hopland, Calif., Sept.; 1 ♀, Rowena, Oreg., Sept. 1, 1923 (on flowers of *Eriogonum umbellatum*). Mr. R. H. Foxlee of Robson, B.C., kindly sent me several specimens for study and donated most of them to the C.N.C.; it gives me pleasure to dedicate one of the new species to him.

Spilomyia foxleei n.sp.

Figs 1, 3, 5, 7, 10

Male—Length, 14.8 mm. Wing length, 10.4 mm. Head yellow, the following black or dark brown: occiput (except about lower 1/5), vertex, upper half of front, a triangle above antennae, a narrow median line on lower 3/5 of face, and a small spot on upper margin of cheek. Hairs of upper part of occiput, of vertex, and of front mostly black; hairs of face, cheeks, and lower part of occiput white. Face in profile (Fig. 3) very slightly concave, without trace of tubercle; lower margin of head horizontal. Eye red, the following black: entire marginal band, irregular vertical stripe joining marginal band above, and a number of irregular spots in front of the stripe. Antenna dark reddish-brown; second segment (measured along outer surface) slightly longer than first or third; arista reddish-yellow.

Thoracic dorsum black, the following yellow: most of humerus, an adjacent rounded spot, a small spot on posterior half of notopleuron, postcallus, a curved line extending anteromediad from postcallus to suture and ending in a silver-pollinose mark, an inverted V in front of scutellum, and broad posterior margin of scutellum. Mesoscutum with broad, faint, posteriorly divided, median pollinose stripe, best seen in posterior view, on anterior 2/3. Pleura black with five large yellow spots: one each above front coxa, on posterior margin of mesopleuron, on upper margin of sternopleuron, on posterior 2/3 of pteropleuron and extending from its upper margin to a short distance below the upper margin of hypopleuron, and on laterotergite (posteroventrad of lower squama). The last three spots broadly confluent. Black portions of thoracic dorsum mostly black-haired, rest of thoracic hairs almost all yellow. Flattened part of mesopleuron immediately behind anterior spiracle, hypopleuron below posterior spiracle, and metasternum with long fine hairs. Upper margin of hypopleuron bare. Subscutellar fringe absent.

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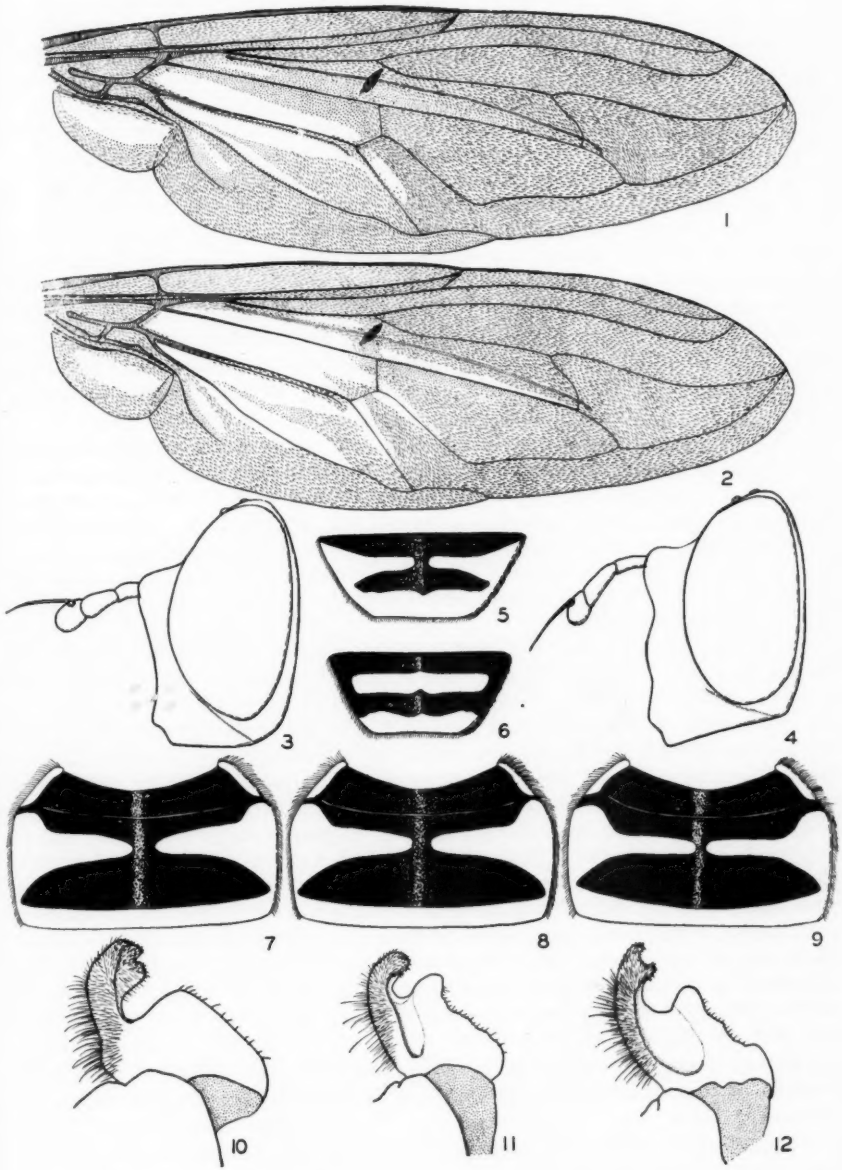

Figs. 1-2. Wing, showing distribution of microtrichia (strokes indicate microtrichia on at least upper surface; dots, microtrichia on under surface only). 1, *Spilomyia foxleei*, n.sp., 2, *S. citima* n.sp.

Figs. 3-4. Head, male. 3. *S. foxleei*. 4. *S. citima*.

Figs. 5-6. Tergite 5, female. 5. *S. foxleei*. 6. *S. citima*.

Figs. 7-9. Tergites 1 and 2, male. 7. *S. foxleei*. 8. *S. interrupta* Will. 9. *S. citima*.

Figs. 10-12. Left surstylus, lateral vitw. 10. *S. foxleei*. 11. *S. interrupta*, 12. *S. citima*.

Wing in front of posterior branch of radial sector brownish, paler apically; rest of wing hyaline. Membrane (Fig. 1) with bare areas (unmarked) and areas with microtrichia on lower surface only (stippled); rest of membrane with microtrichia on upper surface (and usually on under surface as well). Haltere yellow. Squama yellowish-white with yellow fringe.

Legs mostly dark yellow, the following pale to dark brown: mid coxa, trochanters, dorsal and posterior surfaces of hind coxa, broad indistinct preapical band on fore femur, most of posterior surface of hind femur, apical fourth of posterior surface of hind tibia, and most of mid and hind tarsi; fore coxa, apical 3/5 of fore tibia anteriorly and apical fourth posteriorly, and fore tarsus, black. Legs mostly yellow-haired, the following with slightly coarser black hairs: extreme apices of coxae and of fore and mid trochanters, all but base of hind trochanter, posterodorsal and ventral surfaces and basal fourth of anterior surface of fore femur, ventral surface and basal part of anteroventral surface of mid femur, and all of hind femur except posterior surface, apical 2/3 of dorsal surface, and a part of anterodorsal surface gradually increasing in width toward apex.

Abdomen (Fig. 7) with tergite 1 black, narrowly yellow laterally; tergites 2 to 4 black, each with two yellow bands: one sub-basal, broadly interrupted medially, and greatly broadened laterally, the other apical, entire, of uniform width throughout and narrowly confluent laterally with the anterior band. Anterior black area of each tergite narrowly extending to side margin. Each half of anterior band of tergite 2 gradually broadened laterad of its inner end for about half its length. Bands of tergite 3 similar to those of tergite 2, anterior band more gradually broadened near outer margin of tergite. Bands of tergite 4 similar to those of 3 but each half of anterior band with subparallel sides on inner half, posterior band broader and narrowed medially. Tergites 1-4 uniformly sub-shining, with very short hairs. Black hairs present on broad, short, triangular area on posterior black area of tergite 2 extending forward to level of interruption of anterior yellow band, on a similar triangle with a narow median extension almost to anterior margin of tergite on tergite 3, and on posterior yellow band of tergite 4 with a narrow median extension onto anterior black area; a few black hairs along posterior margins of tergites 2 and 3; rest of tergites 1-4 yellow-haired. Sternites black with narrow yellow posterior margins; sternites 1 and 2 shining, 3 and 4 pollinose. Posterior 3/4 of sternite 4 with many short, coarse, black hairs and a few yellow hairs, rest of sternites with longer, fine, yellow hairs. Genital segments yellow-brown, almost entirely black-haired. Surstylus (Fig. 10) with a broad base and a broad apical lobe separated by a rather narrow, deep notch; apical lobe with a small subapical notch, with short stout setulae apically and longer finer hairs on rest of surface. Left and right surstyli of same shape.

Female—Length, 14.8-15.9 mm. Wing length, 11.1-12.6 mm. Very similar to male. Upper fourth of front, and a median frontal line which is broadened anteriorly, black; rest of front yellow. Front mostly black-haired. Facial profile as in male. Anterior clouding of wing extending back to spurious vein. Bare areas of wing membrane as in male. Legs as in male except that black hairs of femora may be slightly more or slightly less extensively distributed than in male. Anterior and posterior black areas of tergite 4 sometimes black-haired posteriorly; black hairs of tergites 1-4 otherwise distributed as in male. Tergite 5 (Fig. 5) black with an interrupted sub-basal and an entire apical yellow band, the bands narrowly confluent laterally; a few yellow hairs on outer portions of anterior yellow band, the tergite otherwise black-haired.

Sternite 3 usually with a few black hairs posteriorly, sternites 1-4 otherwise as in male. Sternite 5 pollinose, black-haired, black with posterior margin yellow. Hairs of cerci yellow.

Holotype– ♂, Chilliwack, British Columbia, June 26, 1918 (W. B. Anderson). Type No. 6581, Canadian National Collection.

Paratypes– ♀, Quamichan L., B.C., August 5, 1923; 4 ♀ ♀, Robson, B.C., July 4-August 15, 1954 and 1955 (H. R. Foxlee). In C.N.C., collection of H. R. Foxlee, and U.S.N.M.

Spilomyia citima n.sp.

Figs. 2, 4, 6, 9 , 12

Male–Length, 15.2 mm. Wing length, 10.4 mm. Very similar to *Spilomyia foxleei* n.sp., differing as follows: Occiput obscurely reddish below around posterior margin of oral cavity, otherwise black; cheek entirely brown except for an obscure yellow spot below lower posterior angle of eye. Hairs of upper part of occiput mostly pale. Face in profile (Fig. 4) with a low, blunt tubercle; anterior oral margin produced slightly but distinctly downward. Second antennal segment 1½ times as long as first or third.

Yellow spot on posterior half of notopleuron lacking; scutellum yellow only posterolaterally, median half of posterior margin black. Yellow spot of pteropleuron small, restricted to lower half of sclerite, not extending onto hypopleuron and separated by broad posterior black margin of pteropleuron from yellow spot of laterotergite.

Brownish area of wing extending back to spurious vein on basal half of wing. Bare areas of membrane (Fig. 2) more extensive than in *foxleei*.

All of hind coxa except an obscure patch on anterior surface, and apical 3/5 of posterior surface of fore tibia, dark brown to black. Fore and hind coxae entirely yellow-haired. Four femur posteroventrally with very few, hind femur ventrally and anteroventrally with many black hairs; femora otherwise yellow-haired.

Tergites (Fig. 9) with markings almost as in *foxleei*, but anterior yellow bands of tergites 2-4 less broadly divided, each half of anterior yellow band of tergite 2 parallel-sided over most of its width, anterior yellow bands of tergites 3 and 4 parallel-sided over a little less of their widths than is band of tergite 2 and anterior black areas of tergites 2-4 reaching the side margins over rather more of their length. Tergites 2 and 3 with only a few black hairs near mid line of posterior black area and on extreme posterior margin of tergite; tergite 4 with a few black hairs near mid line of posterior black area, on about median 1/6 and on posterior 1/4 of posterior yellow band; tergites otherwise yellow-haired. Yellow posterior margin of sternite 4 with a few black hairs, sternites otherwise yellow-haired. Surstylus (Fig. 12) narrower than that of *foxleei*, with a broader, shallower notch separating apical and basal portions and with a broader notch in the apical lobe.

Female–Length 12-14 mm. Wing length 11.1-12.6 mm. Very similar to male. Front as in female *foxleei*, median black stripe entire or interrupted below anterior ocellus; black hairs less abundant than in *foxleei*. Posterior half of notopleuron with yellow spot; posterior margin of scutellum broadly yellow. Fore and mid femora entirely yellow-haired, hind femur with few (British Columbia specimens) to many (Washington Territory Specimen) black hairs ventrally. Tergite 2 as in male (Fig. 9) or with anterior black area more extensive laterally; tergite 5 (Fig. 6) black with an entire (B.C.) or narrowly divided

(Wash. Terr.) sub-basal yellow band which does not reach the side margins, and with an entire apical yellow band. Tergites 1 and 2 entirely yellow-haired; tergite 3 yellow-haired (B.C.) or with a few black hairs along extreme posterior margin (Wash. Terr.); tergite 4 with black hairs variable in extent – only on posterior third of posterior yellow band (William Head), on posterior and median portions of posterior black area and along posterior margin of tergite (Similkameen), or on most of posterior 3/5 of tergite (Wash. Terr.); posterior half of tergite 5 mostly black-haired. Sternites coloured as in *foxleei*, 1-3 yellow-haired, 4 entirely yellow-haired (B.C.) or with a few black hairs posteriorly (Wash. Terr.), 5 with a few to many black hairs posteriorly or entirely yellow haired.

Holotype– ♂, Oliver, British Columbia, July 13, 1923 (E. R. Buckell). Type No. 6582, Canadian National Collection.

Paratypes– ♀, William Head, Vancouver I., B.C., August 27, 1921 (W. Downes); ♀, Similkameen, Okanagan, B.C., Sept. 12, 1913 (T. Wilson); ♀, Washington Territory [paralectotype of *Spilomyia interrupta* Williston]. Paratypes in C.N.C., U.S.N.M.

Comparative notes–Curran (1951) has given a key to the 13 species of *Spilomyia* previously known from North America. Both new species run to *interrupta* Will. in couplet 12; the following key separates the three species:

1. Face without a trace of tubercle, lower margin of head horizontal (Fig. 3); black mark on cheek not reaching oral margin; yellow pteropleural spot extending distinctly to upper margin of pteropleuron and narrowly onto upper margin of hypopleuron, and confluent posteriorly with the yellow spot of laterotergite; cell *R* with posterior bare area ending well before level of fork of R_5, cell *1st* M_2 covered with microtrichia (Fig. 1); posterior surface of fore tibia black only on apical fourth; mid femur with many black hairs anteriorly and ventrally, hind femur with basal sixth almost entirely black-haired; surstylus of male as in Fig. 10 ..... *foxleei* n.sp.

   Face with a weak but distinct tubercle, anterior oral margin produced distinctly downward (Fig. 4); black mark on cheek extending to oral margin; yellow pteropleural spot not extending distinctly to upper margin of pteropleuron or onto hypopleuron, and separated from yellow spot of laterotergite by a narrow to broad black line; cell *R* with posterior bare area extending almost to apex of cell, cell *1st* M_2 with a small bare area posteriorly (Fig. 2); posterior surface of fore tibia black on apical 3/5; mid femur with at most two sparse rows of black hairs on apical half of posteroventral surface, hind femur with basal sixth almost entirely yellow-haired 2

2. Yellow pteropleural spot, on posterior half of sclerite, not extending quite to upper margin of lower plane portion of pteropleuron and separated from yellow spot of laterotergite by a very narrow black line; each half of anterior yellow band of tergite 2 gradually widening towards sides, laterally confluent with yellow margin of tergite 1 or separated from it by a very narrow black band (Fig. 8); apex of surstylus of male with at most an obscure depression (Fig. 11); anterior yellow band of tergite 5 of female reaching side margins and confluent laterally with posterior band (as in *foxleei*, Fig. 5) ..... *interrupta* Williston

   Yellow pteropleural spot, on posterior half of sclerite, not extending quite to upper margin of lower plane portion of pteropleuron and separated from yellow spot of laterotergite by a broad black line; each half of anterior, divided, yellow band of tergite 2 parallel-sided over most of its width, laterally separated from yellow margin of tergite 1 by a broad black band (Fig. 9); apex of surstylus of male distinctly notched (Fig. 12); anterior yellow band of tergite 5 of female not reaching side margins and not confluent laterally with posterior band (Fig. 6) ..... *citima* n.sp.

Taxonomic Value of Wing Microtrichia

The distribution of the microtrichia on the wing membrane of species of Syrphidae offers a valuable taxonomic character. Many species (although probably less than half) have the membrane uniformly covered with microtrichia. Others have bare areas near the base of the wing – usually at the

bases of the basal cells and of the anal cell, but often also in the costal cell and on the anal and axillary lobes. The bare areas sometimes extend beyond these cells onto the apical half of the wing. Occasionally, as in *Scaeva* and in many species of *Eristalis*, the membrane is entirely or almost entirely bare. Rarely the basal part of the wing is trichose and the apical part is bare; this is so in *Volucella esuriens* Fab. and in a few related species, and is said by Bezzi (1915) to occur in some species of *Phytomia*. In the above species of *Volucella* the pigmented part of the membrane is densely trichose and the hyaline part is bare, but usually the arrangement of the microtrichia is unrelated to the pigmentation, or at most the microtrichia are denser on the pigmented areas. Usually the microtrichia occur on both the upper and lower surfaces of the wing membrane. Occasionally, as in the two species of *Spilomyia* described above, certain parts of the membrane have microtrichia on one surface only. This may sometimes be of taxonomic importance, but as the surface on which the microtrichia occur can be determined only by very careful examination, for most purposes it should suffice to treat both surfaces as one and merely to record the presence or absence of microtrichia for a particular area. In a few cases the microtrichia are diffusely scattered over an area, but usually they are closely and evenly placed with only a narrow, sparsely trichose transition zone between a densely trichose and an entirely bare area. Bare areas are usually in the central portions of cells but some species of *Eristalis* have the margins of cells bare and the central portions trichose. The spurious vein may be trichose or bare. The extent of the microtrichia is apparently always the same in both sexes of a species. Specimens taken near the end of their life span may have the wings slightly rubbed but these can usually be distinguished by the presence of breaks in the wing margins. There is sometimes slight intraspecific variation in the extent of the microtrichia; this must be borne in mind in taxonomic work but it does not deprive the character of its usefulness.

The extent of the microtrichia (often called villi, an unnecessary term used only by students of Syrphidae) has already been used as a taxonomic character, but references to it are few and its value is apparently little appreciated. Meigen (1822) indicated that most genera of syrphids had the wings haired but that most species of *Eristalis* had them bare (he distinguished *Eristalis* from *Helophilus* in this way), and then divided *Eristalis* into a group with bare wings and a group with haired wings. Several authors have used the absence of microtrichia to distinguish *Scaeva* from related genera. Shannon (1926) used the same character to separate the single American species of *Syritta* from related genera. Bezzi (1915) and Hull (1949) used the arrangement of microtrichia to distinguish several genera of Eristalinae. Barretto and Lane (1947) based the genus *Eurypterosyrphus* partly on the presence of dark, long, fine, abundant microtrichia on the entire wing, and said that *Rhoga xanthoprosopa* Barr. and Lane, a species of a related genus, has the wing uniformly and finely covered with microtrichia. Bezzi (1915) used the arrangement of microtrichia to separate species of *Paragus*, *Phytonia*, and *Eristalis*, Curran (1939) to separate species of *Phytomia*, and Stuckenberg (1954) to separate species of *Paragus;* all three authors considered Ethiopian species only. Herve-Bazin (1926) indicated the extent of wing pubescence in several species of oriental Syrphidae and illustrated its distribution in two species of *Milesia*. Hull (1949a) remarked that the wing of *Lycastrirhyncha titillans* Hull appeared to be without villae. Delucchi and Pschorn-Walcher (1955), in their excellent revision of the European species of *Neocnemodon*, relied heavily on the arrange-

ment of the microtrichia to distinguish species of this difficult genus. Other references to the character undoubtedly occur, but they are infrequent.

A brief survey, mostly of Nearctic species, showed that the distribution of wing microtrichia is of taxonomic value in many genera. Specific differences exist in the genera *Allograpta*, *Baccha*, *Cerioides*, *Chilosia*, *Chrysotoxum*, *Criorhina*, *Epistrophe*, *Eristalis*, *Mallota*, *Melanostoma*, *Merodon*, *Metasyrphus*, *Microdon*, *Mixogaster*, *Neoascia* (differences very slight), *Neocnemodon*, *Orthoneura*, *Paragopsis* (=*Eumerus* auct.), *Paragus*, *Platycheirus*, *Somula*, *Sphaerophoria*, *Sphegina*, *Spilomyia*, *Syritta*, *Syrphus*, *Volucella*, *Xanthogramma*, and *Xylota*. The only larger genera that showed no differences between species were *Chrysogaster*, *Helophilus* s.l., and *Sericomyia*, all the species examined having the entire membrane trichose.

In some genera the character may separate only species as easily distinguished by other means, but even then it may be valuable as a group character. In many cases, though, it separates otherwise very similar species, as demonstrated above for species of *Spilomyia*. *Syrphus ribesii* (L.) has the membrane entirely trichose; *S. vitripennis* Mg., until early in this century not definitely distinguished from *ribesii* (Verrall, 1901, p. 369), has extensive bare areas near the base of the wing. *Epistrophe columbiae* Cn. and *E. nigrifacies* (Cn.) have the membrane completely trichose; *E. albipunctatus* Cn., *E. diversifasciatus* (Knab), and *E. pullulus* (Snow) have extensive bare areas. *E. terminalis* Cn. has the membrane trichose; the very similar species *E. xanthostoma* (Will.) has it partly bare. *Xylota quadrimaculata* Lw. and *X. annulifera* Bigot have an extensive bare area immediately in front of vein *Ax;* the closely related species *X. bigelowi* (Cn.) and *X. binei* (Cn.) have this area almost completely trichose.

The character may prove particularly useful in associating the sexes in groups with marked sexual dimorphism and in separating the females of species otherwise most readily distinguished by differences in male genitalia or secondary sexual characters. It may also provide a useful tool for students of phylogeny.

No serious attempt was made to determine the taxonomic value of the distribution of wing microtrichia in other groups of Diptera, but incidental observations have shown that specific differences exist between some species of the genera *Cyphomyia*, *Hermetia* (Stratiomyiidae), *Psilocephala* (Therevidae), *Machimus*, several genera of Leptogastrinae (Asilidae), as indicated by Carrera (1944, 1947) and Martin (1957), *Empis* (Empidae), *Pipunculus* (Pipunculidae), *Platypeza*, *Agathomyia* (Platypezidae), *Cordilura* s.l. (Muscidae: Scatomyzinae), *Richardia*, *Rivellia*, *Senopterina* (Otitidae), and *Oedicarena* (Tephritidae).

References

Barretto, M. P., and J. Lane. 1947. Novas Microdontinae Brasilieros (Diptera: Syrphidae). *Rev. Ent., Rio de J.* 18: 139-148.

Bezzi, M. 1915. The Syrphidae of the Ethiopian region. London.

Carrera, M. 1944. Chave sinóptica da subfamília Leptogastrinae (Díptera, Asilidae), com a descrição de um nova gênero e una nova espécie. *Pap. Dept. Zool. Sec. Agric. S. Paulo* 4: 85-94.

Carrera, M. 1947. Sôbre o gênero *Leptopteromyia* Williston, 1908 (Diptera, Asilidae). *Pap. Dept. Zool. Sec. Agric. S. Paulo* 8: 89-96.

Curran, C. H. 1939. Records and descriptions of African Syrphidae-IV. *Am. Mus. Novit.* 1026.

Curran, C. H. 1951. Synopsis of the North American species of *Spilomyia* (Syrphidae, Diptera). *Am. Mus. Novit.* 1492.

Delucchi, V., and Pschorn-Walcher. 1955. Les espèces du genre *Cnemodon* Egger (Diptera, Syrphidae) prédatrices de *Dreyfusia* (*Adelges*) *piceae* Ratzeburg (Hemiptera, Adelgidae) *Z. Angew. Ent.* 37: 492-506.

Hervé-Bazin, J. 1926. Syrphides de l'Indo-Chine française. *Encycl. Ent., B, Diptera*, 3: 61-110.
Hull, F. M. 1944. A study of some syrphid flies from South America. *Rev. Ent., Rio de J.* 15: 34-54.
Hull, F. M. 1949. The morphology and inter-relationship of the genera of syrphid flies, recent and fossil. *Trans. Zool. Soc. Lond.* 26: 257-408.
Martin, C. H. 1957. A revision of the Leptogastrinae in the United States (Diptera, Asilidae). *Bull. Am. Mus. Nat. Hist.* 111: 347-385.
Meigen, J. W. 1822. Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten. Vol. 3. Hamm.
Shannon, R. C. 1926. Review of the American xylotine syrphid-flies. *Proc. U. S. Natl. Mus.* 69(9).
Stuckenberg, B. R. 1954. Studies on *Paragus*, with descriptions of new species (Diptera, Syrphidae). *Rev. Zool. Bot. Afr.* 49: 97-139.
Verrall, G. H. 1901. British Flies, Vol. VIII. London.

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A Seventh Species of *Podolasia* Harold (Coleoptera: Scarabaeidae)[1]

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In a previous paper, six species were placed in the genus *Podolasia* Harold (Howden, 1954). Since then an additional, very distinctive, species has been collected in the Big Bend area of western Texas by Mr. L. J. Bottimer, Kerrville, Texas. This species belongs to the group having nine-segmented antennae and bidentate fore tibiae, but differs from all known species in the shape of the clypeus and of the male genitalia.

Podolasia bottimeri new species

Holotype.—Male, length 3.6 mm.; greatest width 1.6 mm. Color uniformly reddish-brown dorsally and ventrally, with elytral apices slightly darker. Clypeus (Fig. 3) anteriorly sharply reflexed and deeply emarginate; sides arcuate, only slightly reflexed. Disc of clypeus flat, with scattered seta-bearing punctures. Posterior edge of clypeus elevated above frons and sharply delimited. Gena laterally rounded in front of eye, posterior and lateral edges forming a right angle by eye. Median frontal area of head irregularly punctate, smooth medially, transverse carina absent; vertex finely reticulate laterally. Inner margin of each eye with a row of setigerous punctures.

Pronotum completely but poorly margined, the margin being setigerously punctate. Disc of pronotum except at midline with scattered coarse punctures, each puncture bearing a long, conspicuous seta. Anterior pronotal angles obtuse, not produced forward beside eyes. Posterior angles obsolete. Lateral margins of pronotum strongly arcuate, widest medially, slightly more narrowed anteriorly. Elytron with only sutural stria indicated; surface with scattered coarse, setigerous punctures, more numerous laterally. Pygidium finely reticulate and setigerously punctate, ventral margin evenly rounded.

Mouth parts, except for palpi, vestigial and not evident. Antenna nine-segmented; first two segments large; suceeding three small, about one-third of

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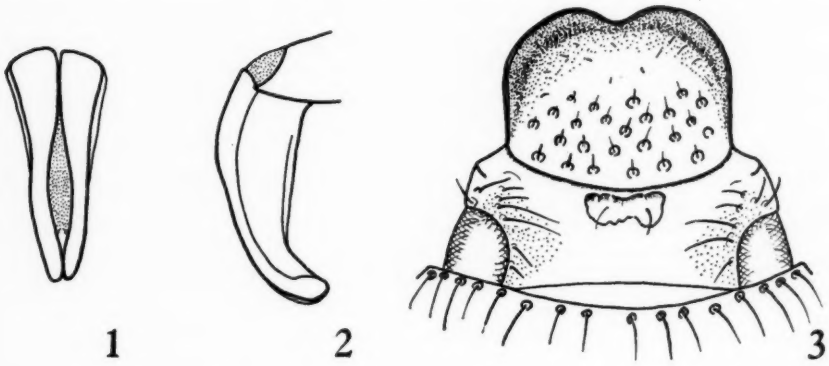

Figs. 1-3. Holotype, *Podolasia bottimeri*, new species. 1. Frontal view of male genitalia. 2. Lateral view of male genitalia. 3. Dorsal aspect of head.

the diameter of the first two; sixth segment reduced and disclike; last three segments forming a club scarcely longer than last segment of maxillary palpus.

Anterior and posterior portions of proepisternum setigerously punctate. Metasternum with scattered large punctures, surface irregularly convex, midline slightly depressed. Anterior abdominal segments connate and finely, setigerously punctate. Tibia of fore leg bidentate, in other respects rather similar to those of *P. ferruginia* (Lec.). Genitalia symmetrical (Fig. 1); the tips reflexed downward, scarcely enlarged laterally (Fig. 2).

Female.—Unknown.

Type Material.—Holotype, male, Hot Springs, Big Bend National Park, Texas, May 5, 1956, L. J. Bottimer; at light (U.S. National Museum). Paratype, 1 male with same data as type (Bottimer Collection).

Variation in the two specimens is slight, the paratype being 4.0 mm. in length and 2.0 mm. in greatest width. The paratype is slightly lighter in color than the type and has considerably fewer dorsal setae. The setae on the pronotal disc are short and inconspicuous, but are still evident in most of the punctures.

This species keys to *pilosa* Howden in "A Review of the Genus *Podolasia* Harold" (Howden, 1954, pp. 3 and 4). It may be distinguished from *pilosa* by the shape of the clypeus (Fig. 3), which is as long as wide and is emarginate anteriorly. The clypeus is the most distinctive feature of the species, being unlike that of any of the other described species. In addition to this, the lack of a transverse carina on the head, the pilose pronotal disc, and the bidentate fore tibia separate it from other species. The male genitalia are very distinctive (Figs. 1 and 2), lacking the lateral expansions at the tips evident in all of the other species.

Reference

Howden, H. F. 1954. A review of the Genus *Podolasia* Harold (Coleoptera: Scarabaeidae). American Mus. Nov. No. 1661. 11 pp.

(Received January 3, 1958)

A Revision of the Genus *Epicorsia* Hübner (Lepidoptera: Pyralidae)[1]

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Hübner (1818:24) erected the genus *Epicorsia*, mentioning two species: *E. mellinalis* Hübner and *E. verticalis* (Linnaeus). Shibuya (1928:280) selected *nyctemeralis* Hübner and Pierce and Metcalfe (1938:58) selected *repandalis* Schiff. as type of *Epicorsia;* both selections refer to a publication other than the original one of the genus and are therefore intrinsically invalid; moreover neither of these species is one of the originally included ones. Accordingly I hereby select *Epicorsia mellinalis* Hübner as type of *Epicorsia* Hübner, in accordance with the usage of Warren (1891) and of most modern authors.

Hampson (1899:255) sank *Epicorsia* to *Pyrausta* and listed *oedipodalis* Guenée and, following Warren (1891), *butyrosa* Butler as synonyms of *mellinalis*. Fernald (1902:389) accepted Hampson's species synonymy but recognized *Epicorsia* as a distinct genus. Schaus (1940:372) referred all these names to *Pyrausta cerata* (Fabricius). Amsel (1954:191) described an additional species, *Epicorsia avilalis*. *Epicorsia*(?) *prummides* Druce (1895:212) does not belong to this genus but seems to be more closely related to *Loxostege mancalis* (Lederer).

Genitalic differences permit the separation of eight species of *Epicorsia*, four named and four unnamed. These have been mixed indiscriminately in collections under the names *cerata* Fabricius or *mellinalis* Hübner. These species are all very similar in external appearance, and differ only in intangible characters of proportions of the wing and intensity of ground colour and maculation. I have not found clear-cut differences in the female genitalia, but the males show striking and consistent differences, and in most cases it has been possible to identify females by association.

Epicorsia parambalis, new species

Fig. 1

Body pale above. Wings slender in male, broader in female, pale yellow, thinly scaled; costa of fore wing and termen of both wings somewhat deeper yellow. Markings as in *mellinalis*, from which the present species differs in the pale and more diaphanous wings and the absence or near-absence of orange tints on body and wings.

Male genitalia somewhat like those of the following two species, but differing in the form of the harpe, which is highest at the middle, with tufts of spines in its basal and middle portions but not in its distal part.

Holotype, ♂, allotype, ♀, Paramba, Ecuador, 3,500 ft., dry season, April and May, respectively, 1897, in the British Museum (Natural History), London.

Paratypes:—In the British Museum (Natural History), seven paratypes, from the following localities in Ecuador: Paramba; Balzapamba, Prov. de Bolivar; La Chima, Prov. los Rios.

In the Canadian National Collection, two paratypes, from Paramba and La Chima, Ecuador, Type No. 6420, C.N.C.

Epicorsia lucialis, new species

Fig. 2

Closely similar superficially to *mellinalis;* ground colour somewhat more opaque; orange tints on the average less pronounced.

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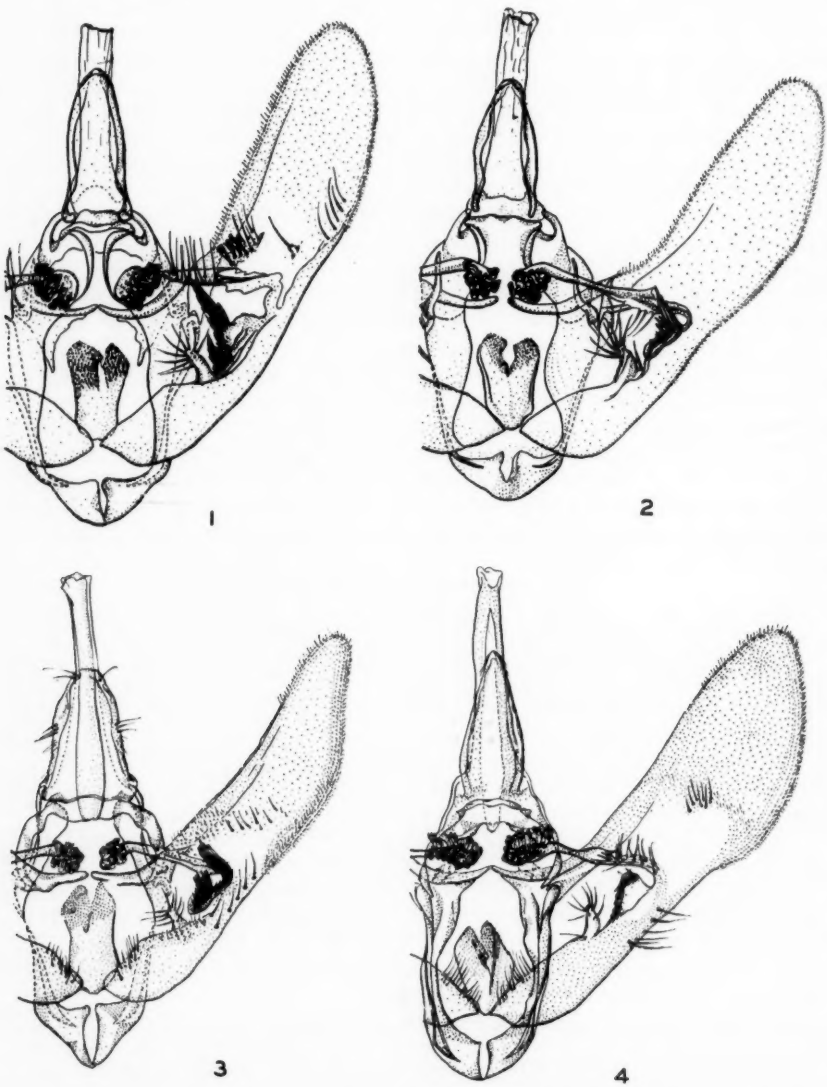
2Senior Entomologist.

Male genitalia with spinose process lenticular, with the comb of spines long distally, becoming shorter rapidly towards basal portion.

Holotype, ♂, and allotype, ♀, St. Lucia, Major Cowie, in the British Museum (Natural History).

Paratypes:—In the British Museum (Natural History), ten, from the following localities in the Lesser Antilles: St. Lucia; Bridgetown, Barbados; St. Vincent; and Mt. Gay Estate, St. George's, St. Andrew's, and Balthasar, Grenada.



Figs. 1-4. Male genitalia of *Epicorsia* spp. 1, *E. parambalis;* 2, *E. lucialis;* 3, *E. chiapalis;* 4, *E. oedipodalis.*

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In the Canadian National Collection, two, from St. Lucia and Barbados, Type No. 6421, C.N.C.

***Epicorsia lucialis baezalis*, new subspecies**

Specimens from the mainland of South America differ as a group from those from the Lesser Antilles in being larger, with stronger orange tints and cross-lines, and in having the process of the valve somewhat more strongly spined. There is considerable variation in the four specimens from widely separated localities of which I have examined the genitalia, and it may well be that more than one species or subspecies is represented; better material will be needed to decide. For the present I associate these four specimens and a female from Trinidad under a single name.

Holotype, ♂, Baeza, East Ecuador, March, 1915, in the British Museum (Natural History).

Because of the taxonomic uncertainty already mentioned I refrain from designating the following specimens as paratypes, but they are referable to this subspecies as I conceive it at present: one ♂, Tarapeto, Peru; one ♂, Mindo, W. Ecuador; one ♂, Cucuta, Venezuela; one ♀, Ariapite Valley, Trinidad; all these specimens in the British Museum (Natural History).

***Epicorsia chiapalis*, new species**

Fig. 3

Epicorsia oedipodalis, Druce, 1895:211 (in part, err. det.).
Epicorsia mellinalis, Druce, 1895:211 (in part, err. det.).

Wings fairly broad, somewhat orange-tinted; fringes of wings and dorsum of abdomen orange-tinted; general facies closely similar to that of *mellinalis*.

Male genitalia with spinose process bearing two distinct sets of spines, the distal one forming a compact tuft, making a barely acute angle with the process, the more basal one at a definite angle to the distal one.

Holotype, ♂, La Granja, Chiapas, Mexico, Aug., 1930, C. C. Hoffman, in the American Museum of Natural History, New York.

Allotype, ♀, Finca La Violeta, Soconusco, Chiapas, Mexico, Aug. 17, 1954, F. Hartig, Type No. 6423, C.N.C.

Paratypes:—In the American Museum of Natural History, one ♀ from Santa Anita, Chiapas.

In the Carnegie Museum, Pittsburgh, one ♂, Sixola R., Costa Rica.

In the British Museum (Natural History), 7 ♀♀, from; Volcan de Chiriqui, Panama, 2-3,000 ft.; Pantaleon, 1,700 ft.; Cubilguitz and Teleman, Vera Paz; Candelaria Mts., Costa Rica; Sixola R.; and Atoyac, Vera Cruz.

This species is closely related to the preceding, and may on future study prove to be better ranked as a subspecies of it. Because of the genitalic differences I keep it distinct for the present.

***Epicorsia oedipodalis* (Guenée)**

Fig. 4

Botys oedipodalis Guenée, 1854:336.
Botys butyrosa Butler, 1878:493.
Pyrausta mellinalis, Hampson, 1899:255 (in part, err. det.).
Epicorsia mellinalis, Fernald, 1902:389 (in part, err. det.; *oedipodalis* as synonym).
Pyrausta cerata, Schaus, 1940:372 (in part, err. det.).

Wings more opaque and clearer, brighter yellow than in preceding species, outer margin not orange-tinted or narrowly and weakly so.

Male genitalia with process of valve triangular with a narrow zone of very short spines along the dorsal margin.

This species occurs in the Greater Antilles, except Puerto Rico, and in Florida. Material examined:—115 specimens from: Jamaica, Hispaniola, Cuba, Grand Cayman, Bahamas (Bonhote), and Florida (Biscayne Bay and Florida City). It has been reared from "wild coffee" in Jamaica. I have examined the types of *oedipodalis* and of *butyrosa*, and the identification can be considered definite.

Epicorsia cerata (Fabricius), new combination

Fig. 5

Phalaena cerata Fabricius, 1795:208.
Botys oedipodalis, Möschler, 1891:283 (in part, err. det.).
Botys cerata, von Hedemann, 1894:283.
Pyrausta mellinalis, Hampson, 1899:255 (in part, err. det.).
Epicorsia mellinalis, Wolcott, 1923:193 (in part, err. det.).
Pyrausta cerata, Schaus, 1940:372 (in part).

Externally similar in most respects to the preceding species, but even brighter yellow and with the transverse lines not so strong; fringes of both wings narrowly but strongly orange-red, much more so than in *oedipodalis*.

Male genitalia with process of valve long and dorsally emarginate, with even fringe of spines of moderate length.

Through the kindness of Dr. S. L. Tuxen and Dr. Niels Wolff, I have a sketch of the genitalia of a specimen of *cerata* believed to be part of the type series of *cerata*. Dr. Tuxen writes as follows:

"Ph. cerata was described in Entomologia Systematica vol. 3 part 2 1794 p. 208 no. 294. The locality was given thus: Habitat in Americae Meridionalis Insulis Dom. Smidt, that means that Mr. (= Dom. = Dominus) Smidt has collected it in the islands of Central America. These islands most often means the formerly Danish West-Indian Islands, now Virgin Islands. —The type of this species ought to be in Fabricius' own collection in Kiel which collection we have borrowed at present. The type is not there. The two specimens in our collection are from an old collection made by two pupils of Fabricius and studied continuously by him. The two specimens are labelled cerata by one of these pupils but possess no locality label. There is however every reason to believe that they are part of the material used by Fabricius for the description and so may well be called types."

Material examined:—39 specimens from: Puerto Rico; Guadeloupe; and Dominica. One of the Dominica specimens was reared, but no food-plant is given.

Epicorsia avilalis Amsel

Fig. 6

Epicorsia mellinalis, Druce, 1895:211 (in part, err. det.).
Epicorsia butyrosa, Druce, 1895:211 [?](err. det.).
Epicorsia avilalis Amsel, 1954:191.

Narrow-winged; paler and more transparent than in other species, almost lacking orange tints.

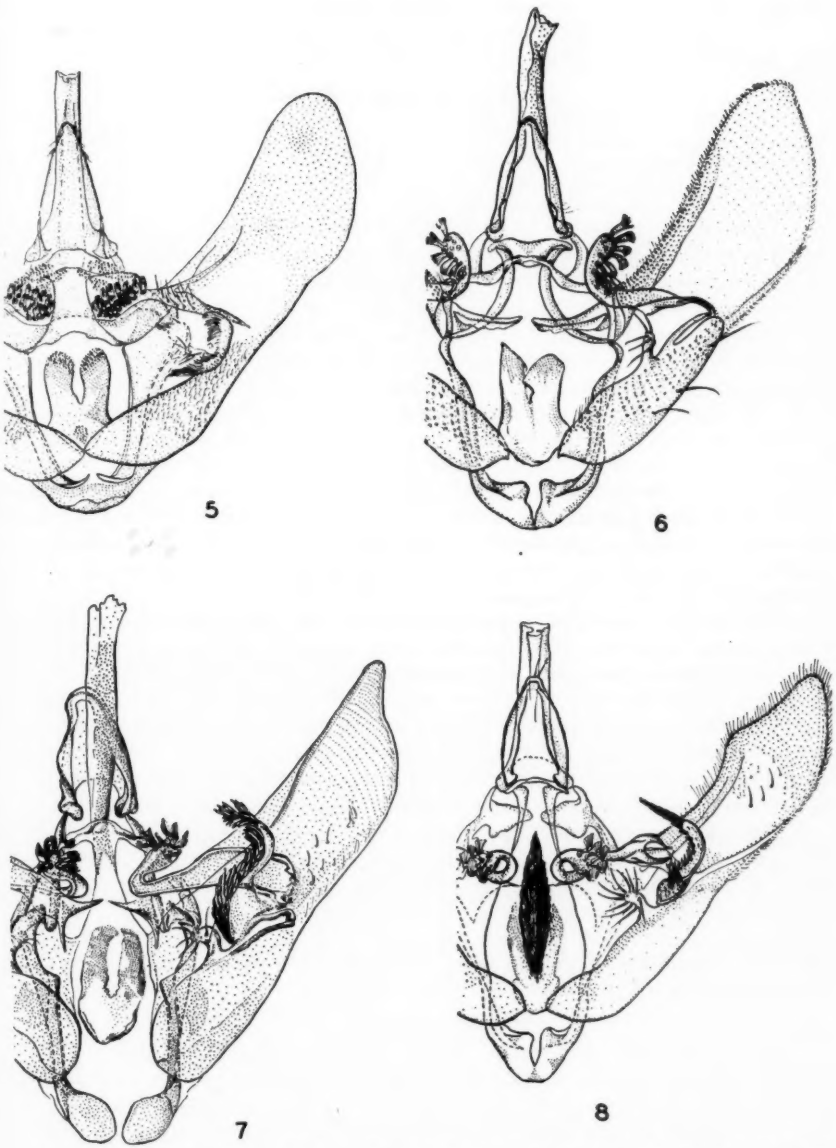
Male genitalia with spinose process of valve lacking.

Through the courtesy of Dr. Amsel I was able to examine the type material of this species before he described it. I have seen 31 additional specimens, from the following localities: Pied Saut, Oyapok River, French Guiana; Cuenta, Venezuela; Panama Canal Zone; Rio Grande, British Honduras; Chichen Itza, Valladolid and Temax, Yucatan, Mexico.

***Epicorsia catarinalis*, new species**

Fig. 7

A large and broad-winged species. Wings not very translucent, pallid, somewhat silky, yellow, with greyish markings; margins not, or only faintly, tinted with orange.



Figs. 5-8. Male genitalia of *Epicorsia* spp. *5, E. cerata;* 6, *E. avilalis;* 7, E. *catarinalis;* 8, *E. mellinalis.*

Male genitalia: valve with outer margin somewhat excised, tip subacute; spinose process very large and prominent, sigmoidal, heavily spined along dorsal margin, distally projecting beyond costa of valve.

Holotype, ♂, allotype, ♀, Rio Vermelho, Sta. Catarina, Brazil; in the Canadian National Collection, Type No. 6424.

Paratypes:—In the Canadian National Collection, 25, from: Rio Vermelho, Corupa and Nova Teutonia, Sta. Catarina, Brazil.

In the British Museum (Natural History), three, from: Hansa Humboldt, Sta. Catarina; Castro, Parana; and Para; all in Brazil.

Epicorsia mellinalis Hübner

Fig. 8

Epicorsia mellinalis Hübner, 1818:24.
Lonchodes mellinalis, Guenée, 1854:355.
Pyrausta mellinalis, Hampson, 1899:255.
Pyrausta cerata, Schaus, 1940:372 (in part).

Hübner's type cannot be located, but as there are old specimens of this genus in the Vienna Museum which might conceivably on further evidence be shown to include a type I refrain from designating a neotype. Hübner's figure is unsatisfactory. I have made a careful check of a number of yellow Pyraustinae from the tropical fauna and find no group that agrees so well with the figure as do members of the present genus. In particular the strong ferrugineous tints on the dorsum of the abdomen of the figure seem to rule out other species that resemble it. It is therefore probably correct as well as convenient to preserve the conventional identification of the genus. However, this leaves the specific identification uncertain. Here the locality is of help. Hübner's species was described from Brazil. Of the eight species only two are represented from Brazil in the considerable material I have examined. Of these two, *E. catarinalis* is scarce and localized, and lacks prominent ferrugineous tints on the dorsum of the abdomen; the present species is more common and is widely distributed, and has the requisite ferrugineous tints.

This species has fairly strong ferrugineous tints along the outer and costal margins; the transverse markings are rather indistinct in most specimens; the ground colour is somewhat translucent in males but often fully opaque in females.

The male genitalia are very distinctive: the apex of the valve is emarginated on the costal side; the spinose process of the valve is sharply bent, its distal part extending forward to the costa and its spines extending beyond the costa; the juxta bears a prominent brush of black spines, unique in the genus.

Material examined:—107 specimens from the following localities: British Guiana: New Amsterdam; Demerara R.; Christianberg; Potaro; Georgetown. Dutch Guiana: Aroewarwa Creek, Maroewyn Valley; Paramaribo. Venezuela: San Esteban Valley, Las Quiguas. Colombia: Cinea, Juntas; Rio Dagua; Condoto, Choko Prov. Ecuador: Bulimi; Paramba, 3,500 ft.; Cayapas. Brazil: Pará; Serra de Communaty; Pernambuco; Itanhaen, São Paulo; Hansa Humboldt and Corupá, Sta. Catarina.

Distributional Notes

The geographic distribution of this genus, although probably not fully known, presents features of interest. The four species *lucialis*, *chiapalis*, *oedipodalis* and *cerata* appear to form a vicarious group or superspecies (Fig. 9). The two mainland representatives are closely related; the two from the Greater Antilles are much less similar to the mainland species and to each other; the Puerto Rican species is less similar to the mainland species than is the Cuban

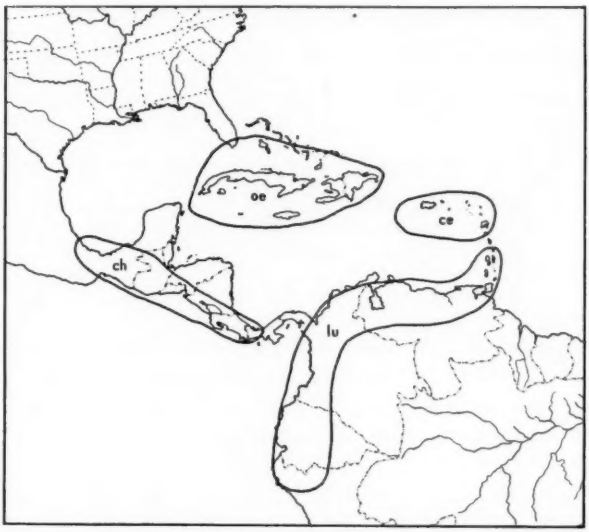


Fig. 9. Ranges of members of the *Epicorsia cerata* group: oe = *E. oedipodalis;* ce = *E. cerata,* ch = *E. chiapalis;* lu = *E. lucialis.*

one. This is a pattern commonly repeated in other groups. The easiest historical interpretation is that there have been three waves of immigration into the West Indies. The earliest, represented by *cerata,* has penetrated from Central America as far as Guadeloupe, but has subsequently become differentiated from the mainland type. The second wave, represented by *oedipodalis,* has displaced *cerata* in Cuba, Jamaica and Hispaniola, and has in its turn become differentiated from the mainland type. The third and most recent wave, represented by *lucialis,* has followed the Lesser Antillean route, and presumably penetrated until it met the southern limit of *cerata.* No collections are available from Martinique, and it is not known which, if either, of the species occurs on that island. The invasion by *lucialis* has been so recent that there has been time only for minor subspecific differentiation. In this case there is no direct evidence of whether we are dealing with divergent insular forms and a conservative mainland stock, or with a progressive mainland stock and relict insular forms. However, in some comparable cases in butterflies (*Battus philenor* group, *Papilio thoas* group) the insular forms appear to be primitive, and the mainland ones progressive.

The four species whose ranges are shown in Fig. 10 are only distantly related, and their distributions are presumably independent. The apparent zonal concentration of ranges around the coast may be the result of the localization of collecting; however, no species is represented in very extensive collections from central and southern Peru and from Bolivia, including the eastern, Amazonian part of the latter country. The superficially closely similar "*Pyrausta*" *thermicruralis* Hampson group has an almost complementary range, and may perhaps fill the same ecological niche in the central and southern Andes and interior.

Fig. 10. Ranges of *Epicorsia* spp.: av = *E. avilalis;* me = *E. mellinalis;* pa = *E. parambalis;* ca = *E. catarinalis.*

Acknowledgments

I am very greatly indebted to those who have loaned material, made comparisons, checked references and otherwise helped in this study: in particular I may mention Dr. H. G. Amsel, Buchenberg bei Peterzell/Baden, Germany; Mr. Harry K. Clench, Carnegie Museum, Pittsburgh, Pa.; Dr. Walter Forster, Munich, Germany; Dr. E. M. Hering, Berlin, Germany; Prof. A. B. Klots and Dr. F. H. Rindge, American Museum of Natural History, New York; Messrs. E. L. Martin and N. D. Riley and the Trustees of the British Museum (Natural History); and Drs. S. L. Tuxen and Niels Wolff, Universitetets Zoologiske Museum, Copenhagen, Denmark. Messrs. F. Plaumann and A. Maller collected useful material. Miss Marie D'Aoust made the genitalic drawings with her usual care.

References

Amsel, H. G. 1954. Eine neue Pyraustine aus Nord-Venezuela. Z. *Wien. Ent. Ges.* 39:191-192.

Butler, A. G. 1878. A list of Lepidoptera collected by B. B. Bowrey in Jamaica. *Proc. Zool. Soc. London,* 1878, pp. 480-495.

Druce, H. 1895. Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera. Vol. II, signature 2ee. London.

Fabricius, J. C. 1795. Entomologia systematica. Vol. 3, part 2. Kiel.

Fernald, C. H. 1902. Family Pyralidae, subfamily Pyraustinae. *In,* H. G. Dyar, List of North American Lepidoptera. *U.S. Nat. Mus. Bull.* 52, pp. 371-395.

Guenée, A. 1854. Species général des Lépidoptères. Tome huitième. Deltoides et Pyralites. Paris.

Hampson, Sir Geo. F. 1899. A revision of the moths of the subfamily Pyraustinae and family Pyralidae. Part II. *Proc. Zool. Soc. London,* 1899, pp. 172-291.

Hübner, J. 1818. Zuträge zur Sammlung exotischer Schmettlinge. Vol. 1, text. Augsburg.

Möschler, H. B. 1891. Die Lepidopteren-Fauna der Insel Portorico. *Abh. Senckenb. Naturf. Ges.* 16:69-359.
Pierce, F. N., and J. W. Metcalfe. 1938. The genitalia of the British pyrales with the deltoids and plumes. Oundle, Northants.
Schaus, W. 1940. Insects of Porto Rico and the Virgin Islands — Moths of the families Geometridae and Pyralididae. *New York Acad. Sci., Sci. Surv. Porto Rico and Virgin Is.* 12:291-417.
Shibuya, J. 1928. The systematic study on the Formosan Pyralidae. *J. Fac. Agr., Hokkaido Imp. Univ.* 22:1-300, Pl. I-IX.
Warren, W. 1891. Synonymic notes: Pyralidae. *Entomolog. t* 24:180-185.
Wolcott, G. N. 1923. Insectae Portoricensis. *J. Dept. Agr. Porto Rico* 7:1-313.
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Rearing the Army Cutworm, *Chorizagrotis auxiliaris* (Grote) (Lepidoptera: Noctuidae), in the Laboratory[1]

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Cutworms are excellent insects for investigations on physiology, behaviour, and toxicology in the laboratory. Although they are often plentiful and easily obtained in the field during outbreaks their use as laboratory animals is dependent upon satisfactory methods of rearing. Cutworms vary in life history and feeding habits, and many species require distinctive rearing techniques.

The army cutworm, *Chorizagrotis auxiliaris* (Grote), is frequently a pest in the semi-arid regions of the Great Plains of the United States and Canada. The seasonal history is characterized by an apparent period of aestivation during July and August. The necessity of duplicating this in the laboratory may account for the paucity of information on rearing methods for this insect.

In 1955, during an outbreak of the army cutworm in southern Alberta, larvae were collected in the field and reared to adults in the laboratory to obtain data on mortality from disease and parasites. For various investigations on toxicology, physiology, and ecology, methods were developed to rear this insect efficiently and to maintain a constant supply of eggs, larvae, pupae, and adults.

Eggs are obtained from moths that emerge in the laboratory. On emergence, 15 to 25 males and females are placed in an oviposition cage made from an animal jar six inches in diameter by eight inches in height and containing soil sifted through a 50-mesh screen to a depth of half an inch. The cover of the jar is fitted with a circular piece of window screen, and a pleated strip of paper towelling is placed inside as a resting surface for the moths. Food for the moths consists of a 10 per cent solution of honey and water. An arrangement for feeding cutworm moths has been described (Jacobson and Blakeley, 1957).

After emergence the cages containing moths are placed at 15°C. for about 30 days, the honey-water solution being replaced at weekly intervals. Then the cages are placed at room temperature or at a constant temperature of 25°C. and the moths commence laying eggs within about 10 days. The honey-water solution is replaced every second day and eggs are collected daily by sifting the soil through a 50-mesh screen.

After incubation (about five days at 25°C.) the eggs are ready to hatch

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or may be stored for later use at 0°C. To ensure a constant supply of all stages, about 1,000 eggs are hatched each week. Fully incubated eggs are stored at 0°C. and used as needed, and eggs older than 30 days are discarded.

When larvae are required, fully incubated eggs are placed on moistened blotting or filter paper in a stacking preparation dish four inches in diameter by two inches in height. Small leaves of lettuce or dandelion are placed in the dish for food. To prevent escape of the newly emerged larvae, the upper edge of the dish is sealed with a sheet of Parafilm (Marathon Corporation, Menosha, Wisc.). After the first moult a loose-fitting lid is adequate.

In the third instar no more than 200 larvae can be reared in the small preparation dish and the numbers must be reduced or the larvae transferred to a larger container. Larger stacking dishes, eight inches in diameter by 3½ inches in height, are satisfactory and each can be used for 200 to 300 larvae. If larger numbers are required, over 500 per container, metal or glass baking dishes are used. For this purpose, rectangular containers 17 x 12 x 2.5 inches with slightly sloping sides are used.

When larvae are required, the sand is sifted and the desired number in the stage required are selected.

Initially, several kinds of food were used, including sprouts of wheat and barley and leaves of lettuce, dandelion, and alfalfa. Repeated tests showed that dandelion is superior to the others in producing large larvae of uniform size. Lettuce is satisfactory but because of its high moisture content the substrate often becomes very moist and this favours disease development.

Generous quantities of dandelion leaves are placed on the surface of the sand. When they are consumed, the uneaten portions are removed and fresh leaves are provided. Above 20°C., new food is supplied daily.

Dandelion and alfalfa may be transplanted into pots in the fall and grown in the greenhouse for feeding during the winter.

The best method of obtaining pupae of uniform size is to select nearly mature larvae from the rearing containers to complete their development singly, each in a 15-x-60-mm. petri dish. They are then fed daily with dandelion until they reach the prepupal stage, which is distinguished by a yellowing of the ventral surfaces and shrinking in size. The date of pupation is recorded on each petri dish and the dishes with the pupae are placed in trays for emergence. At room temperature about 20 to 25 days are required until emergence. During the pupal period, the sex is determined (Waters, 1943, page 13) and recorded on the petri dish, and the males and females are separated before emergence.

The moths are kept at 10°C. for periods of 100 days or longer with very little mortality if they have access to food and are provided with a resting surface of paper towelling. Since eggs cannot be held at 0°C. for longer than 30 days, storing the moths at low temperatures provides a method of keeping the insect for a prolonged period or for ensuring a supply of eggs at a future date.

At a mean temperature near 25°C., from 50 to 60 days are required from hatching until emergence of moths.

References

Jacobson, L. A., and P. E. Blakeley. 1957. A method of rearing the pale western cutworm, *Agrotis orthogonia* Morr. (Lepidoptera: Phalaenidae), in the laboratory. *Canadian Ent.* 89: 87-89.

Waters, H. F. 1943. Rearing insects that attack plants. *In* Chemical control of insects, ed. by F. L. Campbell and F. R. Moulton, pp. 3-28. American Assoc. Advanc. Sci. Pub. 20, Washington, D.C.

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Hydrogen-ion Concentrations in Alimentary Canals of Third-instar Larvae of Three Species of *Hylemya*[1]

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The hydrogen-ion concentration of the alimentary canal of insects has been studied by many workers. In their review of this subject, Day and Waterhouse (1953) conclude that the pH of the foregut is often the same as that of the food, that of the midgut varies in different species from 3 to 10, but that of the hindgut rarely varies far from neutrality. Various methods of determining pH and their relative merits have been discussed by Waterhouse (1940). He considers that incorporating pH indicators into the food is the most accurate method with insects that are too small to enable their gut pH to be measured electrometrically.

The authors undertook this work as part of an extensive study of digestion in larvae of *Hylemya* spp. because pH has an important effect on the activity of digestive enzymes.

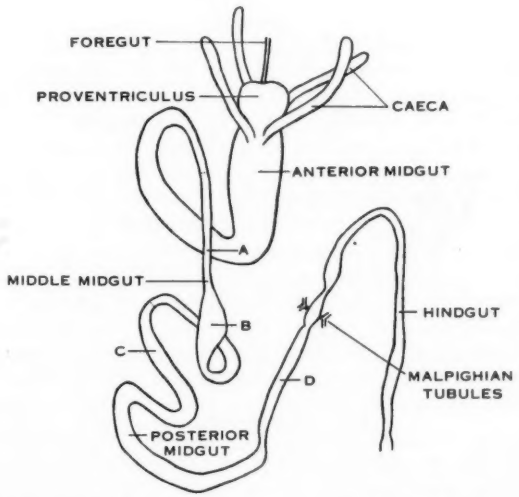

Fig. 1. Schematic drawing of the alimentary canal in third-instar larvae of three species of *Hylemya*, showing the pH zones.

Methods

Third-instar larvae of the cabbage maggot were fed on turnip slices, those of the onion maggot on slices of onion sets, and those of the seedcorn maggot on pea seedlings. The food of each species was placed on filter paper in a petri dish and soaked with a pH indicator solution. The following sulphonphthalein indicators were used as 0.04 per cent solutions in very dilute sodium hydroxide: chlorphenol red, phenol red, bromcresol purple, bromphenol blue, bromthymol blue, cresol red, bromcresol green, thymol blue.

Ten to 15 maggots were placed in each petri dish and incubated at 25°C. for one-half to three hours. Within this period, and sometimes within 10

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TABLE I

Hydrogen-ion Concentrations for Various Parts of Alimentary Canals of Third-Instar Larvae of Three Species of *Hylemya*

Insect	Midgut					Hindgut
	Anterior midgut	Middle		Posterior		
		Zone A	Zone B	Zone C	Zone D	
H. antiqua	6.0–6.7	5.0–6.0	4.4–5.0	6.0–6.7	7.3–7.7	7.3–7.7
H. brassicae	6.0–6.7	5.0–5.6	4.4–4.6	6.7–7.3	7.3–7.7	7.3–7.7
H. cilicrura	6.0–6.7	3.8–4.4	3.8–4.4	6.7–7.3	7.3–8.1	7.3–8.1

minutes, the dye was seen in the hindgut. Each larva was then dissected, the gut was disentangled (Fig. 1), and the colors of the indicator in various regions of the gut were compared with standard pH solutions.

Results

The pH of the foregut was 6.0 in all three species; this was identical with that of the food. Table 1 shows that the pH of the anterior midgut in all three species ranged between 6.0 and 6.7. Two distinct zones (A and B, Fig 1), were distinguished in the middle midgut in each species. The first zone was rather acid, the pH being 5.0 to 6.0 in *H. antiqua*, 5.0 to 5.6 in *H. brassicae*, and 3.8 to 4.4 in *H. cilicrura*. The second zone was the most acid part of the alimentary canal in each species, ranging in pH from 4.4 to 5.0 in *H. antiqua*, from 4.4 to 4.6 in *H. brassicae*, and from 3.8 to 4.4 in *H. cilicrura*. Two zones were distinguished also in the posterior midgut of each of the three species (C and D, Fig. 1). The anterior portion was slightly more acid in *H. antiqua*, pH 6.0 to 6.7, than in *H. brassicae* or *H. cilicrura*, pH 6.7 to 7.3. The posterior portion ranged in pH from 7.3 to 7.7 in *H. antiqua* and *H. brassicae* and from 7.3 to 8.1 in *H. cilicrura*. The pH of the hindgut in each species was identical with that of the posterior zone of the midgut.

Discussion

The hydrogen-ion concentrations of the alimentary canals of third-instar larvae of *H. antiqua*, *H. brassicae*, and *H. cilicrura* are very similar and differ little from those of most other species of dipterous larvae that have been studied critically. It is perhaps noteworthy that *H. cilicrura*, the species with the widest range of host plants, has the lowest pH of the three species for the middle midgut and the highest pH for the posterior midgut and hence may have a more facile digestive system than the other two species.

Observations through the body wall of the larvae showed that there is a violent movement of food in the gut. Food particles oscillated between zones C and D approximately 30 times per minute. It is remarkable, therefore, that the pH zones are so sharply delineated. Preliminary studies indicated that the cells in the gut wall of each pH zone have certain distinctive features that differ from zone to zone.

Summary

Five zones similar in pH from species to species were found in the alimentary canals of third-instar larvae of the onion maggot, *Hylemya antiqua* (Meig.), the cabbage maggot, *H. brassicae* (Bouché), and the seedcorn maggot, *H. cilicrura*

(Rond). The larvae were fed various sulphonphthalein indicators. The gut of each larva was removed after one-half to three hours and the hydrogen-ion concentrations of the various areas in the gut were determined by matching the colors developed in the gut against a series of standard solutions of known pH. The foregut had the same pH as the food, 6.0. The anterior midgut was slightly less acid, the pH being 6.0 to 6.7; the middle midgut was acid and had two pH zones, the pH varying with the species from 3.8 to 6.0 and from 3.8 to 5.0; the posterior midgut also had two zones, the pH ranging from 6.0 to 7.3 and from 7.3 to 8.1. For each species, the pH of the hindgut was identical with that of the last portion of the posterior midgut.

References

Day, M. F., and Waterhouse, D. F. 1953. The mechanism of digestion. *In* Insect physiology, ed. by K. D. Roeder, pp. 311-330. John Wiley and Sons, Inc., New York, N.Y.

Waterhouse, D. F. 1940. Studies of the physiology and toxicology of blowflies. 5. The hydrogen-ion concentration in the alimentary canal. Australia Counc. Sci. Ind. Res. Pamphlet 102: 7-27.

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Identities of Species of *Lecanium* Burmeister in Canada (Homoptera: Coccoidea)[1]

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This paper describes females and some of the larval stages and male "puparia" for species of *Lecanium* known to occur in Canada. Also, it tenders a solution toward establishing a name for a North American species that has been confused with *L. corni* Bouché as identified by Marchal (1908).

In 1903 Fernald listed about 80 species of *Lecanium*, of which about 20 were recorded from Canada. All of these species were defined largely on the basis of differences in size, shape, and colour and of the host or food plant on which they were collected. Sanders (1909) re-examined the types of the North American species and concluded that nearly all of them were merely variations of a single species, *Lecanium corni* Bouché as identified by Marchal (1908). Sanders' conclusions were supported by Ebling (1938), who showed that in *L. corni* size and shape of the mature female scale are, to a considerable degree, determined by the species of the food plant involved. In Europe, Marchal (1908) and later Sulc (1932) attacked the problem through consideration of morphological differences in the larvae and males and of the glandular structures and their waxy secretions in the females. Their general conclusions were similar to those of Sanders, and a relatively small number of species were recognized, each with a lengthy list of synonyms.

In the present work, which is based on the classification of Sulc (1932), only

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five species are recognized. The main purpose of this work is to provide keys and descriptive notes that will aid in distinguishing them, as well as indicate their distributions and food plant preferences.

The material examined comprised that in the Canadian National Collection, which represents the accumulation of about 50 years' collecting. A considerable amount of freshly collected material was provided by Mr. H. R. Boyce, Crop Insect Section, Science Service Laboratory, Harrow, Ontario, to whom special thanks are gratefully extended.

Key to Partially Grown Females[1]

1. Dorsum bearing a group of large, cribiform pore plates just anterior to anal cleft (Fig. 3, D) 2
   Dorsum lacking cribiform plates as above 4
2. Paramarginal "two-ringed" ducts absent 3
   Paramarginal "two-ringed" ducts present (Fig. 13) ..... *coryli* L.
3. A broad band of ventral, paramarginal, glandular ducts (Fig. 3, O); fringe setae equal in length (Fig. 5,F); dorsum bearing scattered, ductless, cribose pore plates (Fig. 3, C) and short, grandular ducts (Fig. 3, G) ..... *cerasifex* Fitch
   Lacking ventral, paramarginal ducts as above; fringe setae unequal in length (Fig. 6); dorsum with small, cribose pore plates that cover orifices of short glandular ducts (Fig. 6) and lacking glandular ducts as above ..... *nigrofasciatum* Pergande
4. Spiracular spines not different from marginal spines ..... *caryae* Fitch
   Spiracular spines longer and thicker than marginal spines and distinctly capitate (Fig. 2) ..... *tiliae* L.

Key to First-Instar Larvae[2]

1. Trilocular, cephalic pores present (Figs. 10, 11) 2
   Trilocular, cephalic pores absent (Fig. 9) ..... *cerasifex* Fitch
2. A dorsal series of bilocular pores near median line on each side (Fig. 10) ..... *coryli* L.
   Dorsal bilocular pores lacking (Fig. 11) ..... *tiliae* L.

Key to Female Second-Instar Larvae

1. Dorsal, paramarginal "two-ringed" ducts absent 2
   Five dorsal, paramarginal "two-ringed" ducts on each side (Fig. 13) ..... *coryli* L.
2. Spiracular spines not capitate, the middle one nearly twice as long as the outer ones (Fig. 1) ..... *cerasifex* Fitch
   Spiracular spines nearly equal in length and distinctly capitate (Fig. 2) ..... *tiliae* L.

Key to Male "Puparia"

1. Dorsum with sutures that extend to the margins (Figs. 15, 16) 2
   Dorsum without sutures but with loose coils of waxy threads (Fig. 17) ..... *tiliae* L.
2. Lateral plates with irregular, rectangular, smoothish areas and a series of five pores on each side corresponding to positions of "two-ringed" ducts of second-instar larva (Fig. 16) ..... *coryli* L.
   Lateral, smoothish areas and pores lacking (Fig. 15) ..... *cerasifex* Fitch

Lecanium coryli L.

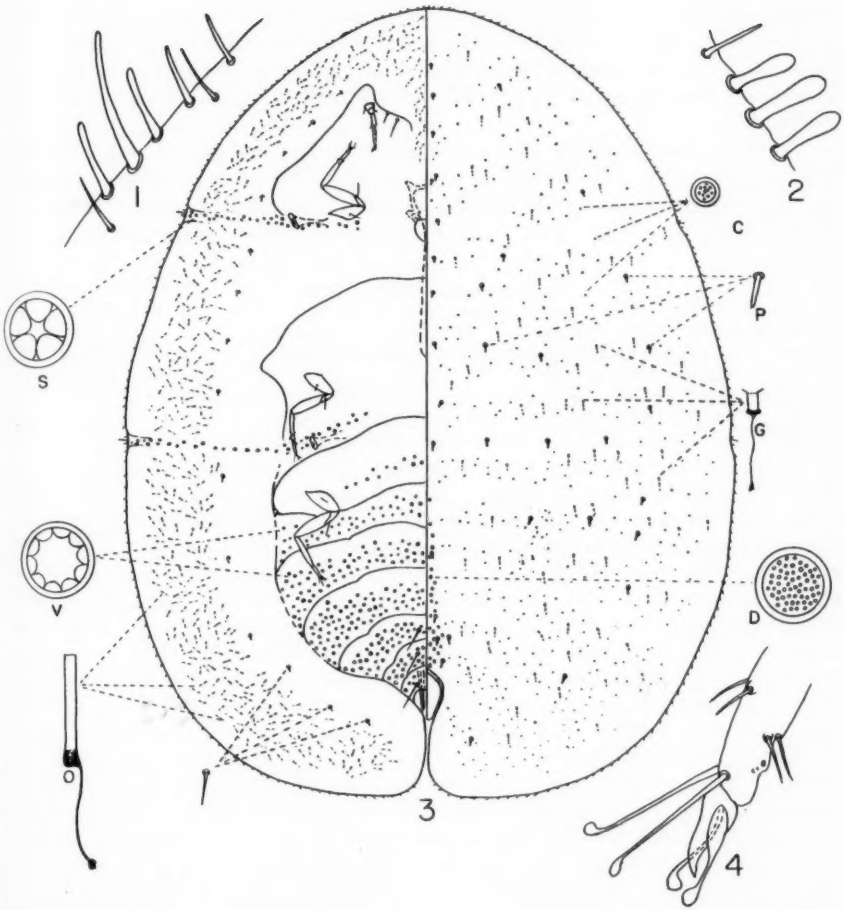
Figs. 10, 13, 16

Lecanium corni (Bouché); Marchal, 1908, p. 264.
Lecanium (*Parthenolecanium*) *coryli* L.: Sulc, 1932, pp. 64, 119.
Eulecanium corni (Bouché): Leonardi, 1920, p. 287.
Eulecanium coryli L.: Bodenheimer, 1953, p. 94.

Female.—Essentially as in *L. cerasifex*, but with eight to 14 paramarginal "two-ringed ducts"; lacking dorsal glandular ducts; usually with scattered, dorsal bilocular ducts.

First-Instar Larva.—Distinguished from that of *L. cerasifex* by having trilocular cephalic pores and dorsal bilocular pores on thorax and abdomen.

[1]In attempting to use this key only partially grown females should be used. In fully grown females the integument becomes much thickened so as to obscure or obliterate details of glandular structures.
[2]Oil immersion is sometimes necessary to use this key.



Figs. 1, 3, 4. *Lecanium cerasifex*. 1, Spiracular spines and a few marginal spines. 3, Diagrammatic outline of a specimen from peach to show main features: S, pentalocular pore from stigmal furrow; V, multilocular pore from venter of abdominal region; O, paramarginal glandular duct; C, small, scattered, dorsal cribose pore plates; R, typical dorsal seta; G, dorsal glandular duct; D, one of large, dorsal cribose pore plates that occur only in median region. 4, claw and apex of tarsus.

Fig. 2. Spiracular spines of *Lecanium tiliae*.

Female Second-Instar Larva.—Distinguished from that of *L. cerasifex* by having five "two-ringed" ducts on either side (Fig. 10).

Male Second-Instar Larva.—Not observed.

Male "Puparium".—Not observed; according to Sulc (1932), different from that of *cerasifex* as indicated in Fig. 16.

Male.—Not observed.

Hosts and Distribution.—Apple: Kentville, Wolfville, N.S. Apricot: Summerland, Kaleden, B.C. Ash: Mahone Bay, N.S. Caragana: Vernon, B.C.; Sackville, N.B. English elm: Indian Head, Sask. Rose: Ottawa, Ont.

Discussion.—This is the *Lecanium corni* Bouché as identified by Marchal

(1908) and most European workers, but is not the species considered to be *L. corni* of North American workers. According to Sulc (1932) and Bodenheimer (1953), the original description of *L. corni* was based on a mixture of species and therefore invalid, and the name *L. coryli* L. should be assigned to this species.

Females of this species are very difficult to distinguish from those of the following one. In fully grown females, as noted by Marchal (1908, p. 271), the paramarginal "two-ringed" ducts are usually apparently absorbed as the integument thickens, and often only amorphous remnants of the ducts can be seen.

Lecanium cerasifex Fitch

Figs. 1, 3-5, 9, 15

Lecanium cerasifex Fitch, 1895, p. 50.
Lecanium corni Bouché: Ebling, 1938, p. 613; Dietz and Morrison, 1916, p. 256; Fenton, 1917, p. 309; Sanders, 1909, p. 443.
Lecanium (*Eulecanium*) *corni* Bouché: Petit and McDaniel, 1920, p. 12.
Lecanium fletcheri Cockerell: Dietz and Morrison, 1916, p. 256.
Lecanium quercifex Fitch: Dietz and Morrison, 1916, p. 258; Sanders, 1909, p. 445.

Female.—Size and form variable, usually oval, nearly flat to almost hemispherical; up to 10 mm. in length. Brown, often with darker markings. Antenna generally seven-segmented, tarsi bearing two dorsal tenent hairs and two of unequal length on each claw (Fig. 4). Venter of median portion of thoracic region lacking pores and ducts except for a number of pentalocular pores in stigmal furrows (Fig. 3, S). Venter of median abdominal region bearing numerous multilocular pores (Fig. 3, V); two parallel, longitudinal rows of setae just anterior to anal cleft, each row consisting of three setae (Fig. 3); a broad submarginal band of glandular ducts (Fig. 3, O), two rows of marginal setae, the ventral row consisting of slender, pointed setae, the dorsal row composed of thicker, bluntly pointed, and more numerous setae (Fig. 1). Spiracular spines bluntly pointed, median one up to twice the length of lateral ones (Fig. 1). Dorsum bearing about five, irregular, longitudinally arranged rows of short, blunt setae (Fig. 3, P); usually a few scattered glandular ducts of similar shape to those of a broad, ventral, submarginal band (Fig. 3, O); scattered, minute, cribose pore plates (Fig. 3, C); scattered, short glandular ducts and a group of large, cribose pore plates anterior to anal cleft (Fig. 3, D). Two fringe setae of equal length on each side of hypopygium (Fig. 3, F); each anal plate bearing two subapical setae and four apical ones (Fig. 5, A, S).

First-Instar Larva.—Distinguished by absence of trilocular cephalic pores and of bilocular pores on dorsa of thorax and abdomen.

Female Second-Instar Larva.—As in Fig. 9.

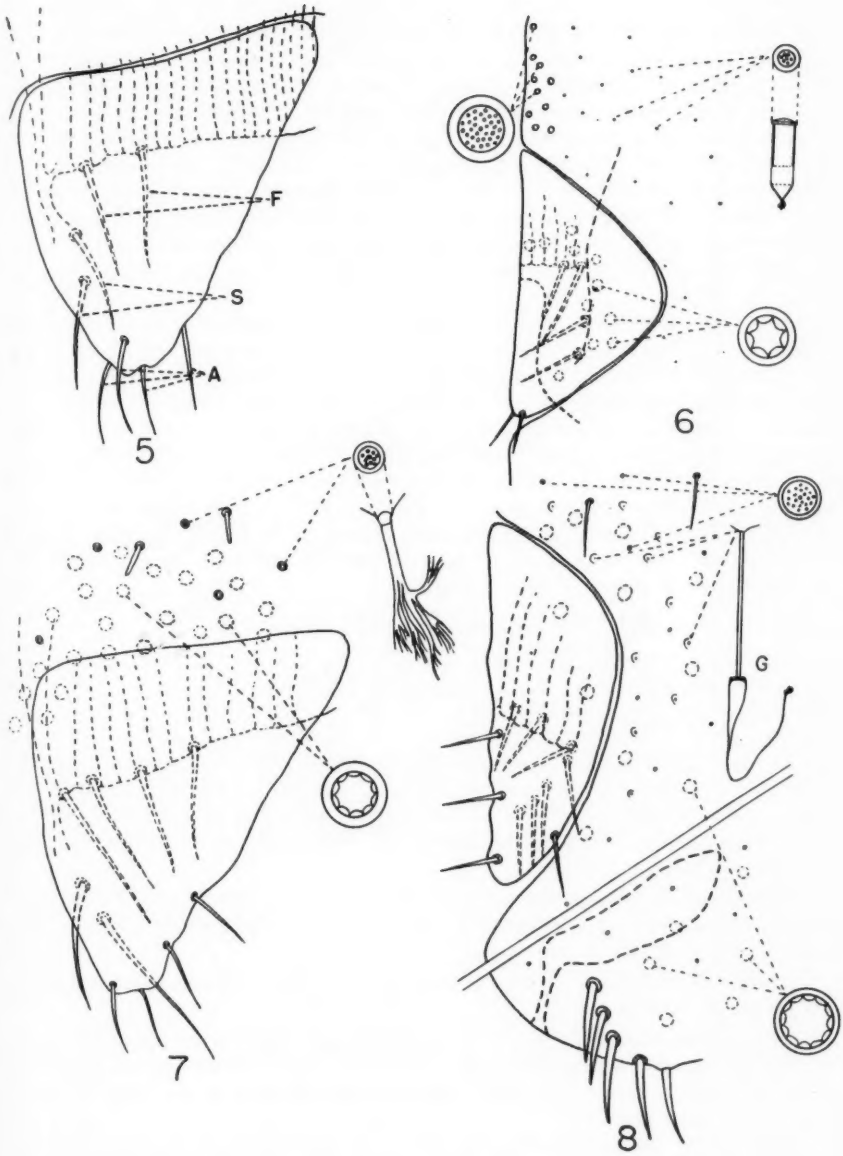
Male Second-Instar Larva.—Not observed.

Male "Puparium".—Composed of six translucent wax plates as in Fig. 15.

Male.—Not observed.

Hosts and Distribution.—Blackberry: Aylmer, Que. Apple: Sherbrooke, Que. Maple: Vineland, Ont. Peach: Vineland, Harrow, Ruthven, Ont. Plum: Vineland, Bowmanville, Ont. Oak: Sarnia, Etobicoke, Ont.; Montreal Que.; Kentville, N.S. *Ribes* sp.; Langley Prairie, B.C. Rose: Sherbrooke, Que.; Ottawa, Ont. Sassafras: Vineland, Ont. *Taxus* sp.; Cedar Beach, Port Burwell, Sheridan, Vineland, Ont. *Tilia* sp.: Centreton, Ont.; Halifax, N.S.

Discussion.—This is the species considered to be *L. corni* Bouché by Sanders (1909) and subsequent North American workers. The species is evidently restricted to North America. The name *L. cerasifex* Fitch is assigned to this



Figs. 5-8. Dorsal views of anal plates and adjacent integument. 5, *Lecanium cerasifex;* F, fringe setae; S, subapical setae; A, apical setae. 6, *Lecanium nigrofasciatum.* 7, *Lecanium tiliae.* 8, *Lecanium caryae.*

species as it is the earliest of the North American synonyms of *L. corni* listed by Sanders (1909, p. 443). Earlier names, *L. tiliae* Fitch and *L. pyri* Fitch, are preoccupied by *L. tiliae* L. and *L. pyri* Schr., both of which, according to Sulc (1932), relate to the species considered to be *L. coryli* L. by Marchal.

The larvae and the females of this species are structurally similar to those of the European oak-infesting species *Lecanium pulchrum* King, from which it differs in that males have not been discovered for *L. pulchrum*, and in which, according to Sulc (1932), there are four or five irregular longitudinal rows of glandular ducts of the same shape as those that comprise the broad, ventral, submarginal band (Fig. 3, O). It is possible that the oak-infesting form of *L. cerasifex* (= *L. quercifex* Fitch of Dietz and Morrison, Sanders, and others) will prove to be the same as *L. pulchrum*, but material examined for this study consisted of mature females that were inseparable from the peach-infesting forms.

Dietz and Morrison (1915) considered the *Thuja*-infesting form a distinct species, *L. fletcheri* Cockerell. It is considered to be a synonym of *L. cerasifex* here as material collected on *Thuja* sp. could not be distinguished structurally from the peach-infesting forms. Kawecki (1954, p. 16) used *L. fletcheri* to designate a species that occurs only on *Thuja* in Poland and in which the first-instar larvae have trilocular cephalic pores. Trilocular cephalic pores have not been observed in the larvae of *Thuja*-infesting forms in North America. Judging from the description given by Habib (1955), *L. taxi* Habib is structurally identical to *L. cerasifex*. However, according to Habib (p. 72) *L. taxi* occurs only on species of *Taxus*, a feature that has not been demonstrated for the yew-infesting forms in North America.

Lecanium tiliae L.

Figs. 2, 7, 11, 17

Lecanium coryli (L.): Marchal, 1908, p. 295.
Lecanium (*Eulecanium*) *tiliae* L.: Sulc, 1932, pp. 87, 119.
Eulecanium coryli (L.): Leonardi, 1920, pp. 296, 514.
Lecanium tiliae L.: Bodenheimer, 1953, p. 96.

Female.—Distinguished from those of *L. coryli* and *L. cerasifex* by having distinctly capitate spiracular spines (Fig. 2), scattered fimbriate dorsal ducts (Fig. 7), and a different chaetotaxy on hypopygium and anal plates (Fig. 7), and lacking simple cribose pore plates and dorsal bilocular and parmarginal "two-ringed" ducts.

First-Instar Larva.—Distinguished from that of *L. cerasifex* by having trilocular cephalic pores and from that of *L. coryli* by the absence of dorsal bilocular ducts (Fig. 11).

Female Second-Instar Larva.—Similar to that of *L. cerasifex*, but has capitate spiracular spines.

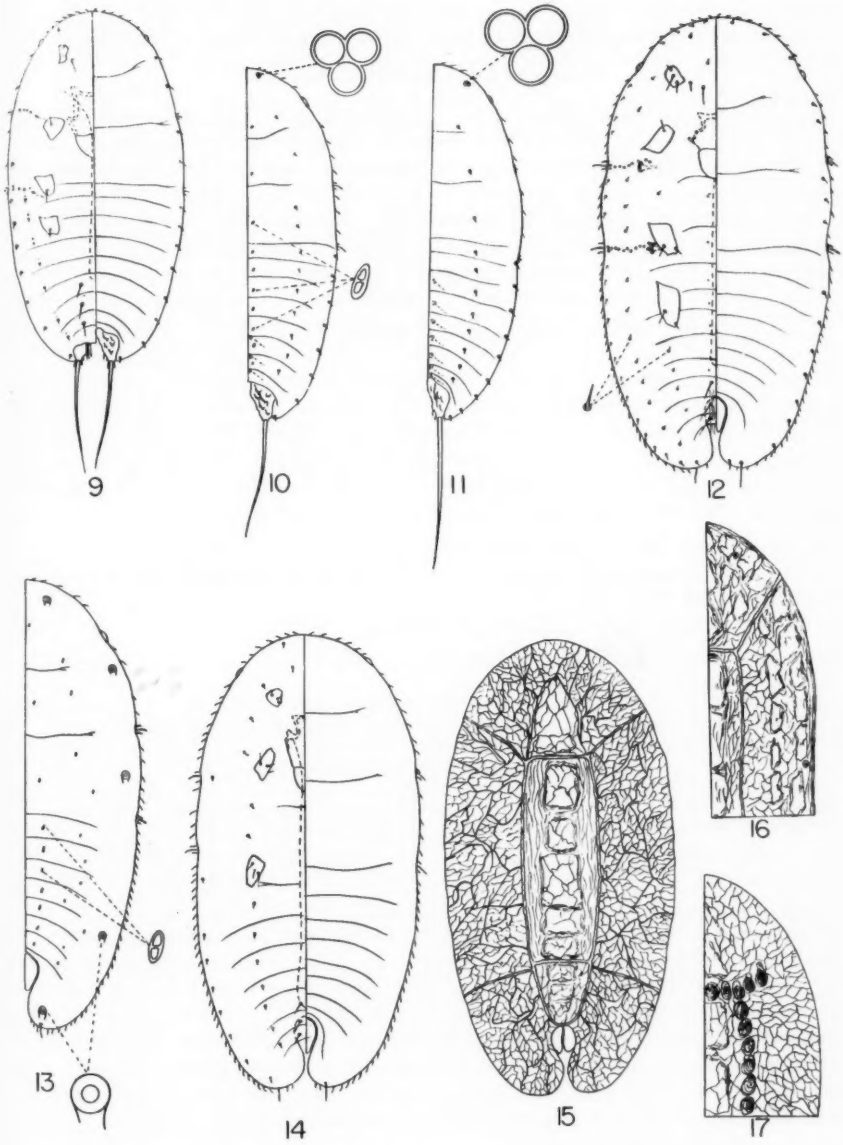
Male Second-Instar Larva.—Distinguished from female second-instar larva by having dorsal, paramarginal glandular ducts and median dorsal glandular ducts, the arrangement of the latter corresponding to that of the coils of waxy threads on "puparium".

Male "Puparium".—As in Fig. 17.

Male.—Not observed.

Hosts and Distribution.—Apple: Lulu Island, B.C. Hazel: Victoria, B.C. Maple (*Acer circinatum* and *A. macrophyllum*): Vancouver, B.C. Peach: Victoria, B.C. Plum: Lulu Island, Vancouver, B.C. *Rubus* sp.: Vancouver, B.C.

Discussion.—This species is the *L. coryli* of Marchal (1908) and subsequent



Figs. 9-11. First-instar larvae. 9, *Lecanium cerasifex*. 10, *Lecanium coryli*. 11, *Lecanium tiliae*.

Figs. 12-14. Second-instar larvae. 12, *Lecanium cerasifex*. 13, *Lecanium coryli*. 14, *Lecanium nigrofasciatum*.

Figs. 15-17. Male "puparia". 15, *Lecanium cerasifex*. 16, *Lecanium coryli*, after Sulc (1932). 17, *Lecanium tiliae*.

workers. According to Sulc, as the name *L. coryli* L. must be used for the species designated as *L. corni* Bouché by Marchal, then *L. tiliae* L. becomes available for the species designated as *L. coryli* L. by Marchal (1908) and others.

Lecanium nigrofasciatum Pergande

Figs. 6, 14

Lecanium nigrofasciatum Pergande: Dietz and Morrison, 1916, p. 251; Sanders, 1909, p. 446.
Lecanium (Eulecanium) nigrofasciatum Pergande: Petit and McDaniel, 1920, p. 14.

Female.—Reddish-brown.—Up to 4 mm. in length. Antenna usually six-segmented. Legs similar to those of *L. cerasifex*. Venter of body lacking paramarginal band of glandular ducts; a few scattered, simple pores and a few multilocular pores (7 or 8 locules) near anal cleft; pentalocular pores in stigmal furrows; two to four median, irregular, longitudinal rows of setae anterior to anal cleft. A single row of slender, pointed, curved, widely spaced marginal spines; spiracular spines longer than marginal ones, bluntly pointed, middle one about twice as long as lateral ones. Dorsum bearing about four or five irregular, longitudinal rows of slender, pointed setae; scattered cribose pores arising from short simple ducts in which the walls sometimes have thinner regions (Fig. 6); bilocular pores and paramarginal "two-ringed" ducts absent; a group of large cribiform pores anterior to anal cleft (Fig. 6). Hypopygium bearing two fringe setae of unequal length on each side; two subapical setae and three apical setae on each anal plate (Fig. 6).

First-Instar Larva.—Not observed.

Female Second-Instar Larva.—Essentially as in *L. cerasifex*, but with fewer ventral setulae (Fig. 14).

Male Second-Instar Larva.—Not observed.

Male "Puparium".—Not observed.

Male.—Not observed.

Hosts and Distribution.—Maple (*Acer dasycarpum*): Hamilton, Ont.

Lecanium caryae Fitch

Fig. 8

*Lecanium caryae Fitch*s Dietz and Morrison, 1916, p. 253; Sanders, 1909, p. 442.
Lecanium (Eulecanium) caryae Fitch: Petit and McDaniel, 1920, p. 11.

Female.—Size variable, up to 15 mm. in length. Dark brown. Antenna six-segmented. Legs as in *L. cerasifex*. Venter of median part of thoracic region lacking ducts and pores. Lacking pores in spiracular furrows. Venter of abdominal region with many multilocular pores (12 locules) (Fig. 8). A broad band of paramarginal glandular ducts as in *L. cerasifex*. Spiracular spines of same shape and size as marginal spines. Sometimes with vasiform, marginal ducts varying in number (Fig. 8). Dorsum of body with a few scattered, slender, pointed setae and with numerous, small, cribose pore plates and glandular ducts (Fig. 8). One or two fringe setae on each side of hypopygium; each anal plate bearing three setae on median margin, one or two apical setae, two or three subapical setae, and sometimes a dorsal set near lateral margin (Fig. 8).

Larval stages.—Not observed.

Male "Puparium".—Not observed.

Males.—Not observed.

Hosts and Distribution.—Peach: Vineland, Ont.

References

Bodenheimer, F. C. 1953. The Coccoidae of Turkey, III. *Rev. Fac. Sci. Univ. Istanbul* 18 (4): 91-164.

Cockerell, T. D. A. 1899. Tables for the determination of the genera of Coccidae. *Canadian Ent.* 31: 273-279.

Dietz, H. F. and H. Morrison. 1916. The Coccidae or scale insects of Indiana. In *Eighth annual report of the State Entomologist of Indiana* for 1914 1915, pp. 195-321.

Ebling, W. 1938. Host determined morphological variations in *Lecanium corni*. *Hilgardia* 11: 613-669.

Fernald, M. E. 1903. A catalogue of the Coccidae of the World. *Mass. Agr. Sta. Bull.* 88.

Fenton, P. A. 1917. Observations on *Lecanium corni* Bouché and *Physokermes piceae* Schr. *Canadian Ent.* 49: 309-317.

Fitch, A. 1859. Third report on noxious and other insects of New York. *New York Agr. Soc. Trans.* 16: 50.

Gemmingham, C. T. 1934. The male *Lecanium corni*. *Ent. Mo. Mag.* 70: 41.

Greene, E. 1934. Observations on British Coccidae, XIV. *Ent. Mo. Mag.* 70: 110.

Habib, A. 1955. On the species of *Eulecanium* Ckll. (Homoptera, Coccoidae, Coccidae) on *Taxus baccata* L. *Ent. Mo. Mag.* 91: 70-72.

Hunter, S. J. 1899. The Coccidae of Kansas, II. *Kansas Univ. Quart.* 8: 67-77.

Kawecki, Z. 1954. Studies on the genus *Lecanium* Burm. II. The yew scale, *Lecanium pomeranicum* sp. n. and some related species (Homoptera, Coccidea, Lecaniidae). *Ann. zool. Warsaw* 16: 9-22.

Laing, F. 1944. A new injurious mealy bug from the Gold Coast. *Bull. Ent. Res.* 35: 93.

Leonardi, G. 1920. Monographia delle cocciniglie italiane. Opera postuma Portici.

Marchal, P. 1908. Notes sur les cochinilles de l'Europe et du Nord de l'Afrique. *Ann. Soc. ent. France* 77: 223-309.

Merrill, G. B. 1953. A revision of the scale insects of Florida. *Bull. State Plant Bd. Florida* 1.

Pettit, R. H. and U. McDaniel. 1920. The lecania of Michigan. *Michigan Agr. Coll. Expt. Sta. Tech. Bull.* 48: 1-35.

Reddick, E. (Mrs.). 1955. A list of Florida plants and the scale insects which infest them. *Bull. State Plant Bd. Florida* 7.

Sanders, J. G. 1904. The Coccidae of Ohio. I. *Proc. Ohio State Acad. Sci.* 4: 27-80.

Sanders, J. G. 1909. The identity and synonymy of some of our soft scale insects. *J. Econ. Ent.* 2: 428-448.

Sanders, J. G. 1910. A review of the Coccidae described by Dr. Asa Fitch. *Proc. Ent. Soc. Washington* 12: 56-61.

Steinweden, J. B. 1929. Basis for the generic classification of the coccid family Coccidae. *Ann. Ent. Soc. Am.* 22: 197-245.

Steinweden, J. B. 1930. Characteristics of some of our Californian soft scale insects (Coccidae). *California State Dept. Agr. Mo. Bull.* 19: 561-571.

Steinweden, J. B. 1946. The identity of certain common species of *Pulvinaria?* (Homoptera). *Microentomology* 11: 1-28.

Sulc, K. 1932. Ceskoslovenske druhy rodu puklice. (gen. *Lecanium*, Coccidae, Homoptera). *Acta Soc. Sci. Nat. Moravicae* 7 (5).

Thomsen, M. 1929. Sex determination in *Lecanium*. *Trans. 4th Int. Congr. Ent. Ithaca, N.Y.*, 1928, Vol. 2: 18-24.

Thro, W. C. 1903. Distinctive characteristics of the species of the genus *Lecanium*. *Cornell Univ. Agr. Expt. Sta. Bull.* 209: 205-225.

(Received October 23, 1957)

Note on the Green-Muscardine Fungus, *Metarrhizium anisopliae* (Metch.) Sor., as a Control for Wireworms[1]

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The fungus *Metarrhizium anisopliae* (Metch.) Sor., which causes a disease in insects known as green-muscardine, was first used by Metchnikoff in 1879 to infect insects artificially. Subsequently it was widely tested as a control agent with a few encouraging results (Steinhaus, 1949).

From 1951 to date the disease was common in a moderately dense population of the introduced elaterid wireworm *Agriotes obscurus* (L.) near Dartmouth, and much less prevalent in a very dense population of a related introduced species, *A. sputator* (L.), near Digby. The higher incidence of the disease near Dartmouth was tentatively attributed to the fact that this area has greater annual rainfall and is more subject to coastal fogs than is Digby. These observations led to the culturing and testing of the fungus in the laboratory and to attempts to increase the incidence of the disease at both Digby and Dartmouth by artificial dissemination of the spores in the soil.

This investigation was of special interest since it had been shown that aldrin, chlordane, and lindane applied to the soil to control wireworms gave at best only temporary control (Fox, in press) and at worst might, if applied frequently, seriously upset the biological associations in the soil and retard the growth of certain crops. The advantages of increasing the effectiveness of an endemic disease of pest insects are obvious, and although the control achieved might not be as great as desired it would at least be self-perpetuating and harmless to agriculture.

In laboratory experiments *M. anisopliae* was readily cultured at room temperature on Sabouraud maltose agar. In exploratory tests to demonstrate the pathogenicity of the fungus, inoculation of 500 gm. of soil in pint containers with 50 ml. of spore suspension containing at least 750,000 spores per millilitre almost invariably caused infection of one to several of the ten larvae in each container. More were infected at 70°F. than at 50 or 60°F. With continual subculturing a decline in the virulence of the fungus was indicated by failure of inoculation to cause disease and therefore fresh isolates of the pathogen were obtained frequently from naturally infected wireworms during subsequent investigations. Contrary to this observation, Rockwood (1950) stated that *Metarrhizium* spp. maintained their virulence on artificial media.

In more critical experiments, larvae of *A. sputator* were confined individually at room temperature (about 70°F.) in vials containing sterilized vermiculite, soil, filter paper or sand. To each vial was added one millilitre of sterile water containing 500,000 to 700,000 spores; an equal amount of sterile water was added to the check vials. The moisture contents of the media were maintained at about 50 per cent water-holding capacity by the frequent addition of sterile distilled water. The disease incidence was consistently at a low level during the 50- to 60-day terms of the experiments. Treatment of the media with spores of *M. anisopliae* caused little or no increase in mortality. Neither the addition of glass splinters to soil or to vermiculite to increase abrasiveness, nor slight injury to the body wall of the wireworm with a fine pin, increased

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[2]Associate Entomologist and Assistant Entomologist.

fungus infection. The percentages of the larvae that were killed by disease are shown in the following table; the values for the checks are in parentheses.

	VERMICULITE	SOIL	FILTER PAPER	SAND
Percentage killed	8(13)	3(3)	10(10)	17(0)
Number treated	38	38	10	6

The low mortality of wireworms confined in the presence of an abundance of fungus spores suggested that some component of the body wall inhibits growth of the fungus. However, when healthy wireworms were crushed and the resulting homogenates were streaked on agar heavily seeded with *M. anisopliae*, no inhibition of spore germination of mycelial growth was observed. Recently Koidsumi (1957), using more refined techniques, has found that cuticular lipids in silkworms inhibit the invading fungus.

Field experiments on the value of artificially disseminating the green-muscardine fungus in the soil were begun near Digby in August, 1954, and near Dartmouth in May, 1955, in hay fields infested with the wireworms *A. sputator* and *A. obscurus* respectively. Latin square split-plot designs were used. Each plot was a rod square, half being left as an untreated check. The fungus was cultured in bran, soil, or peat moss, broadcast at 1.5, 2.0, or 1.5 pounds per half-plot and worked into the soil with a rotary cultivator. All the treated halves of the plots were seeded with a permanent pasture mixture. Sampling of the wireworm population at Digby 3, 9, and 15 months after application, and at Dartmouth, 4 and 15 months after application, gave no indication that the incidence of the disease had been increased.

The low incidence of the disease in laboratory trials in which autoclaved soil was heavily inoculated with spores to give abundant fungus growth suggests that the quantity of fungus is of secondary importance and that an environmental condition reducing the virulence of the fungus is the limiting factor.

The negative results of the field experiments support Steinhaus' (*op. cit.*) statement, "The fungus is so dependent upon the proper conditions of temperature and humidity as to make its artificial distribution impractical except when optimum conditions prevail and when the quantity of indigenous fungus in an area is low". There remains the possibility of changing the soil environment to favour the pathogen; this might be done by modifying certain normal cultural practices, e.g., liming or fertilizing. Possibly some selective fungicide might be included with the pathogen to repress the agents in the soil that apparently inhibit it; certainly this would be an interesting avenue to explore.

Acknowledgment

The authors are indebted to Dr. D. M. MacLeod, Insect Pathology Laboratory, Sault Ste. Marie, Ontario, for identifying the pathogen at the beginning of the study.

References

Fox, C. J. S. In press. Some effects of insecticides on the wireworms and vegetation of grassland in Nova Scotia. Proc. 10th Int. Congr. Ent.

Koidsumi, K. 1957. Antifungal action of cuticular lipids in insects. J. Ins. Psysiol. 1: 40-51.

Rockwood, L. P. 1950. Entomogenous fungi of the family Entomophthoraceae in the Pacific northwest. J. Econ. Ent. 43: 704-797.

Steinhaus, E. A. 1949. Principles of insect pathology. McGraw-Hill, New York.

(Received December 6, 1957)

Book Review

A CRITICAL REVIEW OF THE TECHNIQUES FOR TESTING INSECTICIDES by J. R. Busvine. 186 pp., 551 refs. Commonwealth Institute of Entomology, London. 1957.

This volume, consisting of only twelve chapters, will occupy an important place in the literature on laboratory testing of insecticides. Introducing his discussion with sections on general principles of testing and methods for handling and rearing suitable laboratory test insects, the author deals with stomach poisons, direct contact and residual contact insecticides, and the methods and apparatus available for their study. Fumigants and repellents are handled in similar fashion, while the final chapter deals with pertinent statistical methods.

One reads this book with deceptive ease. The language is precise but flowing. References, though freely used, are introduced smoothly, without interrupting the reader's train of thought. And then the realization strikes one that here is the essence, the sum and substance of the topic, concentrated in a little space, and consequently not to be read casually or carelessly. Few will read this book from cover to cover, but so well is it organized that finding a desired topic is as easy as running a familiar insect through a taxonomic key.

The author has put much of his own knowledge and insight into the pages. Such phrases as "the simplest method" and "a crude technique" sum up the technique for us and at the same time lead to a reappraisal if it happens to be a familiar one. This book will be invaluable to those who desire to improve existing methods of working and thinking or to select the best technique for a particular purpose in a new project. It should be an inspiration to workers in fundamental research, not only because of its positive values but also because it exposes the areas where our knowledge is superficial or absent.

W. S. McLeod,

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Mailed: Wednesday, June 18, 1958